STATISTICS OF COAL.

THE GEOGRAPHICAL AND GEOLOGICAL DISTRIBUTION

OF

Mineral Combustibles or Fossil Fuel,

INCLUDING, ALSO, NOTICES AND LOCALITIES OF THE VARIOUS

MINERAL BITUMINOUS SUBSTANCES,

EMPLOYED IN ARTS AND MANUFACTURES,

ILLUSTRATED BY MAPS AND DIAGRAMS;

EMBRACING,

FROM OFFICIAL REPORTS OF THE GREAT COAL-PRODUCING COUNTRIES, THE RESPECTIVE AMOUNTS OF THEIR

PRODUCTION, CONSUMPTION AND COMMERCIAL DISTRIBUTION,

IN ALL PARTS OF THE WORLD;

TOGETHER WITH THEIR

Prices, Tariffs, Duties and International Regulations.

ACCOMPANIED BY NEARLY

Four Hundred Statistical Tables, and Eleven Hundred Analyses of Mineral Combustibles,

WITH

INCIDENTAL STATEMENTS OF THE STATISTICS OF IRON MANUFACTURES, DERIVED FROM AUTHENTIC AUTHORITIES.

PREPARED BY

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PHILADELPHIA:

PUBLISHED BY J. W. MOORE, 193 CHESTNUT STREET.

1848.

KING AND BAIRD, PRINTERS, NO. 9 GEORGE ST.

PREFACE.

I did not set about this work under the persuasion that I was the most fitting person for a task so arduous; or that I possessed either the necessary facilities for so wide a field of Statistics, or could appropriate sufficient time to its preparation. The fact is, at the outset, it was the result almost of necessity; a preparation for temporary and specific purposes, of a series of comparative details relating to the coal trade of the United States and of certain other countries. The information required was not accessible in any single work, nor even in a number of works; it was no where to be found. The materials, therefore, had to be collected and arranged by degrees, and to be drawn from original sources; and in this manner, the data sought for became the nucleus which has gradually expanded into the substance and capacity of a considerable volume. Of the incompleteness, the multifold imperfections of such a work, especially its first edition; the tendency to error; the innumerable gaps and blanks that remain to be filled up, no one can be so well aware, probably, as its author. An unequal acquisition of statistical details is the inevitable result of all such undertakings. It will not, we admit, be difficult to point out these deficiencies, and critics may suggest abundant omissions and emendations, in this volume. However, as there must be some limit to the accumulative process and some cessation from the collector's toil, it has now become necessary to bring it to a close, and to commit it to the indulgence of the public.

R. C. T.

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PLAN OF THIS WORK.

The growing demand for the species of practical information which it has been our object in the following pages to concentrate, has often suggested itself to the author, and doubtless to numberless others. Perhaps in no country have more frequent inquiries been made in relation to Coal; to its infinite varieties, adaptations and modifications; its innumerable depositories and its geographical distribution, than in the United States of America.

This desire, probably, originates in the circumstance that in no country has such rapid progress been made in the development of mineral fuel, not only for all domestic purposes, but as a powerful agent in every department of manufacturing industry; notwithstanding that enormous and almost unbroken forests still overshadow the land. The increasing demand and corresponding supply, the rapid expansion of the field of industrial operations, have no doubt awakened this solicitude for information—local, general, statistical, commercial and scientific, on the subject of coal.

We have reason, however, to be assured that the demand for this species of knowledge is not limited to the country from whence we date. It prevails more or less in every quarter of the globe where that inestimable substance has been investigated and brought into the service of man. It was obvious that a statistical work, embodying all the important details in relation to the mineral combustibles of the world, would be an acceptable contribution to practical science.

Until some such work appeared, it were a fruitless task to seek for details which no one had undertaken to collect in the compass of a single volume; and which yet remained, like the mineral itself, scattered throughout all the countries of the earth.

Acting under this impression the author has sought and gathered together the materials—a great number at least, to remedy the deficiency of which we speak.

His design, at the outset, was limited to the collection of such coal statistics as seemed sufficient for his private guidance. As in all labours of this description, the materials, during the progress of the undertaking, accumulated to an extent far greater than was anticipated. An extended arrangement led to greatly increased labour. The sources of information as regards foreign countries, being remote, its acquisition is necessarilly uncertain and tedious:

in fact it has no limit, for every day furnishes new facts to be registered. The process never ends, because the elements are inexhaustible. We are reminded, however, by the bulk of the matter on hand that we have reached a point at which we may consign the work to the press.

Preparing these pages in the United States, we are not unaware of the disadvantages which result from the want of access to many official European documents, and of reference to minor authorities such as rarely find their way into American libraries. We may, in some degree, counteract these deficiencies by communicating to Europeon inquirers a great amount of information which our position has enabled us to acquire in America. These persons cannot but contemplate with interest the enormous extent of the North American coal-fields, whose very existence, scarce a quarter of a century back, was unknown, even on their actual sites.

Of the surprising impulse to the interests of the New World which has been communicated by this recent knowledge, this newly acquired power; of the influence it has manifested in many of the commercial and on all of the industrial departments; of the moral consequences which are perceptible in a thousand forms, we shall hereafter submit abundant proofs. It will be much more difficult to speculate as to the position to which these combined elements of prosperity may conduct us in the next quarter or half century. We draw the most sanguine inferences with relation to the future, because the experience of the past twenty-five years fully justifies such flattering anticipations. In that comparatively small period, the consumption of mineral fuel in America has wonderfully augmented: and yet, in the corresponding time in Europe, we are not less astonished to observe the parallel advance in the production of coal, and in the extension of manufactures throughout all the principal countries. In fact, the whole civilized world seems to have made a simultaneous advance in productive industry. It will be our task to point out the exact relative proportions of the progress thus made by each country, during a long series of years and in several successive periods or intervals.

Something further yet remains to be said in relation to the objects contemplated in this volume, and of the several matters to which we have given a place therein.

Our range would have been but narrow had we limited the investigation to mineral coal alone. It is well known that vast deposits of combustible substances have been denominated and described as coal, which the lights of science now shew belong to a more recent class, and to a variety of geological ages or epochs. We refer to the brown coal or lignite class, so abundantly distributed.

In a large portion of Europe, such as the Austrian, Belgian, French and Prussian dominions, the distinction is perfectly well understood, and all official mining statistics are, in these countries, uniformly arranged under their

appropriate classification. In many cases where errors have prevailed, we have been enabled to correct them by the aid of recent geological investigations. Still, modern science has not yet penetrated every where. There remains, at numerous, but rarely visited points, vast fields of so-called coal, whose true geological age we have yet to learn. For the present, therefore, we are unable to class these combustibles either with the true coals as the older series, or with the tertiary lignites as the newer, or with any intermediate deposits. This being the case, it was obviously inexpedient to exclude the LIGNITES from our pages, independently of their intrinsic value as combustibles. Brown coal is a valuable substitute for the older coal where there is a scarcity of the superior variety, as we shall have many opportunities of showing.

In like manner, while describing the lignites, PEAT seemed to demand a proportionate share of our attention, and to claim a place in our columns. The transition from one condition of these combustibles to another is oftentime so imperceptible that they seem to have almost equal claims on our notice. In its remarkable diffusion over the northern hemisphere where artificial heat is so indispensable, and where timber and other descriptions of fuel are so little abundant, turf or peat forms a substitute of inestimable worth. In its adaptation to numberless useful purposes, such as the manufacture of iron, the production of gas, &c., modern science has shown that it possesses qualities which heretofore were but little suspected. Thus, it will be seen, our list comprehends a large series of valuable products; extending upwards from carbonized peat at one extremity to hard coals and compact anthracites at the other.

So closely do some bituminized coals approach to the mineral bitumens, some of which have even been denominated coal, as those in the West Indies and South America, that we have found it advisable to include the BITUMINOUS AND RESINOUS MINERALS. We were unwilling to reject this numerous class, which comprises the solid bitumens of the tropics; the asphalts of France, of Italy, of Syria and numberless other countries; the petroleum of Arabia, of Persia, of Birmah and Ava; the Naphtha of Rangoon, and Tartary and Georgia; the amber of Pomerania, of Saxony and Siberia; the mellite or honeystone of Thuringia, and the retinites of Moravia and England. A number of these substances accompany the carboniferous formations; others arise from the midst of primary and metamorphic and igneous rocks, while still more accompany, or are embedded in the lignite beds and tertiary coals of every part of the world.

We have even added, to complete our series of combustibles, official returns of the annual amount and value of the wood and timber furnished by the forests of France, Austria, the Tyrol, Styria, Illyria, Galicia, Bohemia, &c.

We did not contemplate, in preparing this work, to enter extensively into

the important topic of the statistics of IRON, but we have found it so interwoven with matters essential to our main subject, that a considerable mass of information has been necessarily incorporated in our pages, where will be found the latest estimates and returns of the amount of manufactured iron in all the principal producing countries, illustrated by a diagram of their respective proportions.

Explanatory tables of the current monies, weights and measures of all the leading nations; a variety of statements of commercial facts; details of the respective tariffs, customs and international regulations, in relation to coal; the progress of railroads and canals; of steam power and navigation, and a vast series of analytical tables, besides the maps and diagrams, also occupy portions of the present volume. Among other duties, that of bringing to uniform denominations and a common standard the weights, measures and currency of so many nations, is by no means the lightest. The principal results in our tables have been calculated in the three standards of France, England and the United States.

Where the range of inquiry is so wide, the number of documents which we have had to investigate is correspondingly large. We have endeavoured to designate our authority for every material fact which we have adopted. This recognition, we conceive, is not only in strict justice due to those autherities, but it bestows the sanction of their names, and the weight of their testimony to every page and paragraph of this volume.

Let us add further, that the practice is attended with a convenience which every inquirer can appreciate,—the enumeration of standard authors and the direct reference to their pages. The whole series thus forms, in the aggregate, a copious catalogue of statistical and scientific authorities. The Index, we cannot but think, will be found to concentrate a vast mass of information which has heretofore been dispersed through hundreds of volumes in different languages, and constitutes of itself an epitome or condensation of the entire work.

Of course some embarrassments have, from time to time, been experienced in the arrangement of our statistics. Discrepancies, for instance, frequently appear in the commercial returns of different countries. Thus the returns of the coal exported to France from Great Britain do not strictly correspond with the French tables of imports from the latter country. In like manner, similar variations appear in the official reports of Belgium, Prussia and France. Under the different circumstances of commercial classification, or of local registration, and probably of occasional changes of destination, it would be unreasonable to expect exact conformity.

In a recent bulletin of the central statistical commission of the kingdom of Belgium, something is said on the difficulty which exists in comparing documents drawn up at different sources. Great Britain, it is remarked, has no corps of state engineers, notwithstanding that a desire has been expressed at

different times, even by persons versed in the art of mining operations. In Belgium and in France, those who are engaged in this branch of industry occupy themselves with energy in its details, but submit to the control of the administration, by whose agents every important particular is ascertained and carefully registered. In England, the information of necessity is less precise. The produce of her coal mines is estimated by the number of tons transported by sea to foreign or domestic ports, and on the canals and railroads inland, chiefly to the port of London. A rough estimate remains to be made of the amount conveyed in the interior or consumed upon the spot. It is impossible therefore, to be precise as to the quantity really produced annually in that country.

One European government in the public mining returns, confines itself only to statements of total production, as in Prussia. In this country they calculate the value of the combustibles at the places of extraction: in that, at the centres of consumption; and in a third, at the places of embarkation. Here, the tables furnish the estimated value of the crude minerals; there, their value after they have undergone different preparations. The elements of comparison are often wanting.

It can scarcely be expected that in so new and extensive a country as the United States of America, any organized system is in effective operation for determining the amount of coal yearly raised there. In regard to anthracite, the great avenues from the mines to tide water admit of exact returns of the quantity annually transported, and means exist, in fact, of ascertaining, through the returns of the mining establishments, the true yearly production.

Not so with the production of bituminous coal in the interior. Of this we are wholly uninformed, and the area of the coal-fields is so large, that it seems futile to hazard even the roughest calculation. In 1840, an official attempt was made to acquire that information through the instrumentality of the Census Act, but it proved, as might be expected, a decided and acknowledged failure. In 1845, the Secretary of the Treasury, in conformity with the direction of the Senate, made a report of 419 pages, 6th January, in relation to the statistics of the United States. From no county or state in the Union was a single return obtained as to the coal mines. During the same year, the Secretary of the Treasury, pursuing the inquiry, with reference to the settlement of the proposed tariff, issued circulars throughout all the states, asking information, among other statistics, as to the mines, their produce and prices. His report thereon of 957 pages, dated 3d December 1845, elicited no useful result on this head, nor a single return relative to coal.

The wide distribution of property in America is unfavourable to the collection of such statistics. The process must, at all times, be unpopular, and the results extremely uncertain. This species of investigation savours too much of scrutiny into the private concerns of men, and is unsuited to the spirit of republican institutions.

INTRODUCTION.

SECTION I.

INTRODUCTORY SKETCH.

We take for granted that every one who may chance to peruse the summary of *statistics of mineral fuel* which we have embodied in the present section, will be impressed with the immense importance of those substances, particularly as developed of late years; how vastly enlarged the area and bulk of their production in all countries; how essential they now are to the comfort of the human family; how much they have done towards the extension of the useful arts; how gloriously they have aided the progress of invention and improvement; how mighty are the results which have followed their increased application! For ourselves, we may remark, that during the investigation into the geographical distribution of coal and the subordinate combustibles, nothing has struck us more forcibly than the abundant supply with which Providence has furnished the inhabitants of our globe, particularly in its northern hemisphere. We were astonished at the almost numberless positions where mineral fuel is attainable; especially in North America and Europe. With very inadequate guides at the outset, we have brought together an enormous mass of geological and statistical details, which exhibit an amount and variety of fossil combustibles which far exceeded our original expectations. We have seen how recent is the knowledge of the existence of immense regions occupied by coal, and that every year new positions, new deposits, become known to the traveller, or are demonstrated by the geologist. Through them, and the enterprise of the miner, a rich store of intelligence has been acquired, yet much remains behind. We are yet in the infancy of our knowledge as regards vast areas of country. Busy as the geologist has been during the last half century, how much is yet to be investigated; how wide the space yet untrodden; how ample the fields yet open to the scientific explorer!

The last quarter of a century has, more especially, been prolific in the discovery of the sites of useful mineral combustibles, and in the extended application of their products to the service of the community. Man has not only been taught increased facilities in adapting them to the useful arts, but practical science has apprised him of the great value of substances heretofore accounted of little worth, yet inexhaustibly abundant, and almost every where within his reach. He has acquired, for example, many new facts relative to the value of *peat*, hitherto among the humblest of the combustibles, yet the almost universal production of cold or temperate climates, and of regions which are entirely incapable of producing a growth of timber or of the larger plants. Independent of its applicability to the usual domestic and agricultural purposes, he has seen that it can be successfully applied for

gas-lighting, for steam engines, for evaporation, and for every branch of the iron manufacture, commencing with smelting in the high furnaces, and ending with the most delicate manipulations practised in the working of steel. Thus, in compensation for the absence of the supposed superior descriptions of fuel, coal, for instance, nature has been bountiful of another, where most needed; and one, too, which, unlike fossil coal, is reproductive; always renewable and renewing. The fear, therefore, entertained by some theorists, that the earth will be exhausted of its mineral combustibles, may be alleviated by the contemplation of that enormous supply of vegetable fuel, which prevails where eventually it will be most needed.

It would be no difficult task to show in figures how vastly more profitable is the application of labour in the mining and working and transporting of coal, than in that of the precious metals. The annual production of all the gold and silver mines of North and South America was estimated by Baron Humboldt at £9,243,000, and at present at less than £5,000,000. Now, the value of the coal produced annually, in Great Britain alone, is computed at near £10,000,000 at the pit's mouth, and at from £15,000,000 to £20,000,000 sterling at the places of consumption. At the same time, the value of the iron, brought into a manufactured state through the agency of this coal, is £17,000,000 more. We shall enter more particularly into this subject in a future page. We cannot but mark also the superior character and condition of the inhabitants of the coal producing and consuming countries, such as those of the northern hemisphere, especially since the introduction of steam power, to that of the people of the southern and tropical latitudes, to whom coal has either been wholly denied, or is not applied to any use. The industry, activity, moral culture and intelligence concentrated around any of the great depositories of coal and iron in the temperate regions—in the anthracite districts of Pennsylvania, for instance—have no parallel in the countries from which such treasures have been withheld.*

The two important mineral substances, coal and iron, have, when made available, afforded a permanent basis for commercial and manufacturing prosperity. Looking at the position of some of the great depositories of coal and iron, one perceives that upon them the most flourishing population is concentrated—the most powerful and magnificent nations of the earth are established. If these two apparently coarse and unattractive substances have not directly caused that high eminence to which some of these countries have attained, they, at least, have had a large share in contributing to it.

In preparing this volume, our investigations have in great measure been directed to one only of these simple mineral substances, coal, although the iron has not altogether been lost sight of. We will take the liberty of terminating this passage, in the words of M. Aug. Vischers.

"Coal is now the indispensable aliment of industry; it is a primary material; engendering force; giving a power superior to that which natural

* Let us be permitted to cite a very interesting illustration of the foregoing remark, from the state of Pennsylvania, just referred to. In 1825 commenced the first mining operations in Schuylkill county, and the first concentration of settlers from all countries. In 1841, the central town of Pottsville, originating at a later date than we have quoted, contained the following establishments for the education of the children of the miners and newly settled residents.

Six private schools, numbering 479 pupils; eight public schools, numbering 472 pupils—the annual average expense for each pupil being only $5.82; eight Sunday schools, numbering 1137 pupils; teachers, 166; total, 2254, with a library of 1659 volumes.

It is but just to add, that of the Catholic school, comprising 439 of this number, every individual had taken the pledge of total abstinence from intoxicating drinks *for life*.—Notes from the Miner's Journal of Pottsville, January 1, 1842.

agents, such as water, air, &c., procure. It is to industry what oxygen is to the lungs, water to the plant, nourishment to the animal. It is to coal we owe steam and gas; it replaces, in the workshops and the domestic hearths, the charcoal which had become too costly. Under the last head, in our northerly latitudes, it is destined always to acquire increasing and more general use. The employment of coal will henceforward be no other than a question of cheapness; and, in the present age, the first interest of industry is, above all, to see ameliorated the ways of communication; to lower the tolls upon the routes and the canals. If custom-house officers still oppose shackles on manufactured products, they lower their barriers for the passage of the raw material."

PROPORTIONATE AREAS OF COAL LAND IN EUROPE AND AMERICA.

The following table shows the relative magnitude of the principal coal producing countries, and their respective areas of coal land, together with the proportions which they severally bear to each other. Those of France and Spain are considerably less than the actual amouut. Coal occurs in almost every principal subdivision of Spain, but we have only included the Asturias region.

Countries.	Entire area each country.	Area of coal land.	Proportions of coal to their whole areas.	Proportions, relative parts of 1000 of coal areas
	Sq. miles. English.	Square miles.		
Great Britain, Ireland, Scotland and Wales,	120,290	11,859	1-10	64
Spain, [Asturias region]	177,781	3,408	1-52	18
France, [area of fixed concessions] in 1845,	203,736	1,719	1-118	9
Belgium conceded lands,	11,372	518	1-22	3
Pennsylvania, U. States,	43,960	15,437	1-3	84
British Provinces of New Brunswick, Nova Scotia, Cape Breton, and Newfoundland,	81,113	18,000	1-4½	98
Prussian Dominions,	107,937			
Austrian Prov. containing coal or lignite,	150,000			
The United States of America,	2,280,000		1-17	
The twelve principal coal producing States,	565,283	133,132	1-4	724
		184,073		1000

Hence, as regards European countries, Great Britain takes the first rank: Belgium, as regards territorial proportion, occupies the second rank, although in relative coal area she is the least of the four. Pennsylvania, in respect of territorial proportion, is higher than any of these, being relatively one third: but in absolute area of coal formation, the four eastern colonies of British America united exceeds them all, being larger than that of Great Britain, France, Belgium and Spain conjoined. This table is not strictly perfect; since we possess the areas of the concessions only in France; and, in Spain, only the single coal region of Asturias. We add the areas of Prussia and Austria, but cannot state the proportions of coal formations therein. The American area of coal is nearly three fourths of the whole amount in our table.

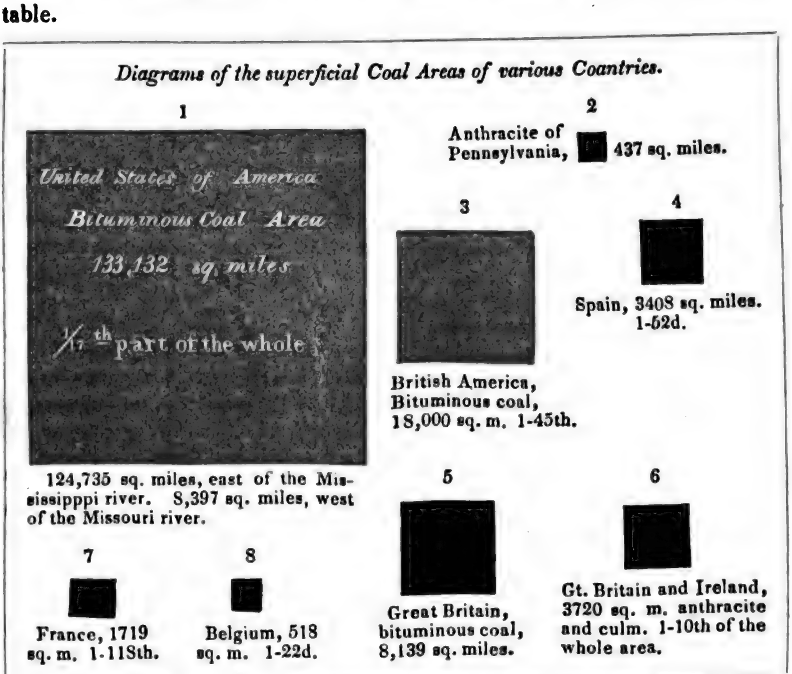
PROPORTIONATE AREAS OF COAL FORMATIONS IN THE UNITED STATES.

The table we here add will be observed with great interest, on account of the enormous breadth of coal formations, in the United States. There are

yet several coal producing States not enumerated, of which we possess very imperfect information.

States.*	Ar. of the States. S. A. Mitchell. Sq. miles.	Coal areas. Sq. miles.	Proportion of coal.	
1. Alabama,	50,875	3,400	1-14	bituminous coal,
2. Georgia,	58,200	150	1-386	about the same amount in N. Carolina,
3. Tennessee,	44,720	4,300	1-10	
4. Kentucky,	39,015	13,500	1-3	
5. Virginia,	64,000	21,195	1-3	
6. Maryland,	10,829	550	1-20	
7. Ohio,	38,850	11,900	1-3	
8. Indiana,	34,800	7,700	1-5	
9. Illinois,	59,130	44,000	3-4	
10. Pennsylvania,	43,960	15,437	1-3	bituminous and anthracite.
11. Michigan,	60,520	5,000	1-20	
12. Missouri,	60,384	6,000	1-10	
	565,283	133,132	nearly 1-4th of 12 States.	

In the persuasion that the diagram form always conveys more accurate impressions than mere tables which embrace a number of figures, we have prepared the annexed diagram showing the Coal Areas of various countries, and the best illustration of the preceding statement. The details of the coal areas in the United States of America follow in the next table.



* We have adopted, in the column of square miles, the areas of Mitchell, published, 1836, rather than those of Darby or McCulloch.

The majority of these States show a far greater proportion of coal than in those of Europe. We omit from the above table some detached coal areas in Arkansas, Missouri territory, Massachusetts, and Rhode Island, respecting which our information is incomplete.

GENERAL SUMMARY OF COAL STATISTICS.

We present, in this place, a comparative view of the coal operations of the larger coal-producing countries of the world. We should have preferred to have arranged the results simultaneously, in all of these countries; but as the dates of the latest returns are not, generally, contemporaneous, we are compelled to a slight deviation from an arrangement otherwise desirable. In general, we adopt the year 1845, for the purposes of comparison.

EUROPE.

Belgium.—In 1844-5 there were in full operation 212 mines, and not in work 97 others, making in all 309 mines, comprising 540 coal pits in operation and construction; and employing 38,500 miners and 500 steam-engines, of an aggregate force of 22,841 horse power. The product of their labour was 4,445,240 tons, which were returned at the value of 39,844,191 francs, at the places of extraction; equal to $7,689,900, or to £1,660,000 sterling. In 1845, the quantity raised was 4,960,077 tons.

Prussia.—In the year 1840 there were about 752 mines or pits of coal, anthracite and lignite in operation. These employed 24,024 miners, and produced 3,245,607 tons, whose value is given in the official returns at 19,687,704 francs, equivalent to $3,806,289, or to £793,860 sterling.

In 1844, the four coal provinces of Prussia produced 3,650,000 tons, of the value of 22,500,000 francs. Three German States of the Zollverein yielded 250,000 tons of the value of 2,250,000 francs.

The Prussian collieries in 1844 employed 25,000 miners:—these returns appear to be incomplete.

France.—During the year 1845, there were, according to official documents, 449 coal mines worked and unworked; employing 30,778 miners, and producing 4,141,617 tons of mineral fuel. Their value at the pit's mouth was 39,705,432 francs = $7,663,000, or to £1,603,106 sterling.

The average quantity raised in each of these three kingdoms in 1845 was remarkably similar; but there is a material difference in the value assigned to the coal at the point of production.*

Great Britain.—As the details of the production and distribution of the coal in this country, [except as regards the coasting trade and foreign exportation,] are not officially registered, as in the continental states we have previously cited, an exact comparison with them can scarcely be instituted. We may state, however, that about 1845-6 the current estimate of the total production of coal in the British mines was thirty-one and a half millions of tons; whose value at the place of extraction was considered to be £9,100,000 sterling,† = 232,000,000 francs, or $44,000,000 annually.

* The Prussian official valuations and the English estimates are much lower than those of France or Belgium. While the aggregate cost of all descriptions of mineral fuel in France was fixed at more than 11½ francs per English ton, the coal and anthracite of Prussia were at 7 francs, and lignite only 2 francs. While the coals of France are valued at 14 francs per ton, and those of Belgium at 13.93 francs, those of Great Britain have only been nominated at 7.43 francs.

† Mr. Tennant, in 1846.

We have before us, however, another statement, in which the production for the year 1845, is rated as high as 34,754,750 tons; of which one third was exported or shipped coastwise, and two thirds were consumed in the interior. The value assigned is £9,450,000, equal to $45,738,000.

AUSTRIA.—The fifth European government in whose provinces coal or lignite abounds, and in which there has been a considerable increase in the extraction of those substances of late years, is the Austrian Empire. We are, however, unable to institute, with accuracy, a comparison with those countries we have just cited. The provinces which contain coal and lignite comprise an area of about 150,000 English square miles, but how much of this is covered by coal formations does not appear to be determined, except partially. In 1845, there were only 659,340 tons produced. The consumption, since that period, has greatly increased, owing to the extension of iron works, manufactures, railroads, and steam navigation on the Danube, on the Adriatic, &c. Bohemia alone produces the greater half of this coal.

UNITED STATES OF AMERICA.

One of the most characteristic features of this immense country, is that of the enormous areas of forest and mountain, which remain almost in their primitive solitude. Within these regions, vast ranges of coal formations exist; their limits, imperfectly defined by the geologist, and scarcely more productive now than at the period of the earth's first occupation by the aboriginal races. Under such a condition of things, it were scarcely just to compare them with the well worked fields of European industry. It must suffice that we exhibit the proportionate extent of surface, occupied by coal formations, as compared with the aggregate area of the whole country. This we have partly effected in a previous page, and we can, to some extent, show an approximate estimate of the annual production.

In a few of the older states which border on the Atlantic, the extraction of mineral fuel commenced, as it were, but yesterday. Yet has it advanced with a rapidity unprecedented in the world, and already has attained an importance among the industrial occupations, which it would be difficult to estimate in figures.

Proportionate areas of coal to the whole of the United States, and to the coal producing states.

	Square miles.		Acres.
The United States contains, exclusive of Texas and Oregon,	2,280,000	=	1459,200,000
The exact boundaries or areas of coal and anthracite formations cannot yet be exactly defined, in each state: in a previous table we have detailed the closest approximation to those results, at present attainable.	133,132	=	85,204,480
The aggregate area of the twelve coal producing states is,	565,283	=	361,781,120

The United States coal area is thus shown to be one seventeenth part of the entire area of the states, (with the exceptions stated,) and to be one fourth part of the aggregate area of the twelve principal coal states.

If we are to credit the census returns in 1840, the relative proportions of

capital employed in coal mining, iron making, and lead and other minerals mined, was, then as follows, viz.:—

Employed in the iron trade in the United States, -	$20,432,131
In lead and other minerals, - - - - - -	1,820,061
In coal operations, - - - - - - -	6,224,464
	$28,476,656

We shall demonstrate, in the progress of this volume how rapid and enormous has been the increase in these matters, but especially as relates to coal operations in the United States.

Production of coal and anthracite in the United States.—By returns to Congress, made under the census act of 1840, the following summary of the coal trade of that year was obtained.*

	Anthracite.	Bituminous coal 28 bushels to one ton.	Total.
Number of tons of 2240 lbs. each,	863,489	985,828	1,849,317
Number of workmen employed,	3043	3,768	6,811
Capital invested,	$4,355,602	1,868,862	6,224,464
Proportion of capital to production,	$5 per ton.	$2 per ton.	

We well know that these returns are, in general much understated, and it is also understood that no returns whatever were received from whole districts, so that, for statistical accuracy, few persons place any reliance upon the results. The difficulty arose, partly from inattention in the agents, but still more from a natural unwillingness among individuals concerned, to make known their private affairs, their capital, and the amount of their business undertakings.

Production of anthracite in 1845, 2,023,052 tons, entirely derived from Pennsylvania. In 1846, 2,343,992 tons. In 1847, 2,982,309 tons.

Of the amount of bituminous coal annually consumed it is impossible to hazard even a guess, but it is doubtless considerably less than that of anthracite.

Were we to offer a very rough approximation to the result for the year 1847, we might say, aggregate of anthracite and bituminous coal nearly 5,000,000 tons. Value at the place of production, $7,500,000. Value at the place of consumption, $20,000,000.

In each case, being probably below the actual result.

Among all the states in the American Union we can only make selection of one, which admits in strict fairness of being compared, in its details, with the coal countries of Europe. This comparison is interesting, and gives a striking proof of the remarkable mineral importance and the flattering prospects of a country so advantageously circumstanced.

Pennsylvania.—Unlike the countries of continental Europe, mineral statistics are here, owing to the free character of its political institutions, attainable with considerable difficulty. There are no records of the number of mines in operation, of the number of workmen employed, the population supported in the coal districts, the amount of production, its cost, and numerous details of interest with which the periodical returns of France, Prussia, Belgium, &c., minutely abound. The attempt to acquire this in-

* Hazard's U. S. Statistical Register of 1840, p. 359; also Hunt's Merchant's Mag. 1842, p. 287; also Baltimore Report, Nov. 16, 1843.

formation during the process of taking the United States census of 1840, was only partially successful. The objections and difficulties attending the former inquiry, will scarcely be obviated even by a more perfectly digested plan, and a more effective organization on a future occasion.

Pennsylvania coutains 43,960 square miles = 28,134,400 acres. The areas in this state which are occupied by anthracite, semi-bituminous and bituminous coals, equal to 9,862,600 acres.

Hence, it appears, that Pennsylvania has more than one-third of her whole superficies covered by productive coal formations; a proportion more than three times greater (relatively) than Great Britain, the most productive of the European countries, and almost double the proportionate coal area of the British American coal producing provinces. Our previous table has shown that there are three other states, in the Union, namely, Kentucky, Virginia and Ohio, that preserve the same ratio of one-third, as Pennsylvania. Indiana has one-fifth, and Illinois has no less than three-fourths of her entire area occupied by the carboniferous strata. These six sovereign states comprise 279,755 square miles, and average each 46,626 square miles; approaching nearly to the size of England, which has 49,643.

	Tons.	Miners.
Production in 1840.—The census return shows of anthracite, ...	859,686	2997
Of bituminous coal, returned in bushels, . .	415,023	1798
In Pennsylvania, . .	1,274,709	4795

The foregoing abstracts illustrate the coal statistics of the most important countries in the world. We now proceed to present the details for the purposes of comparison, in a concentrated form. The results, for the first time brought under review, are of a very interesting nature.

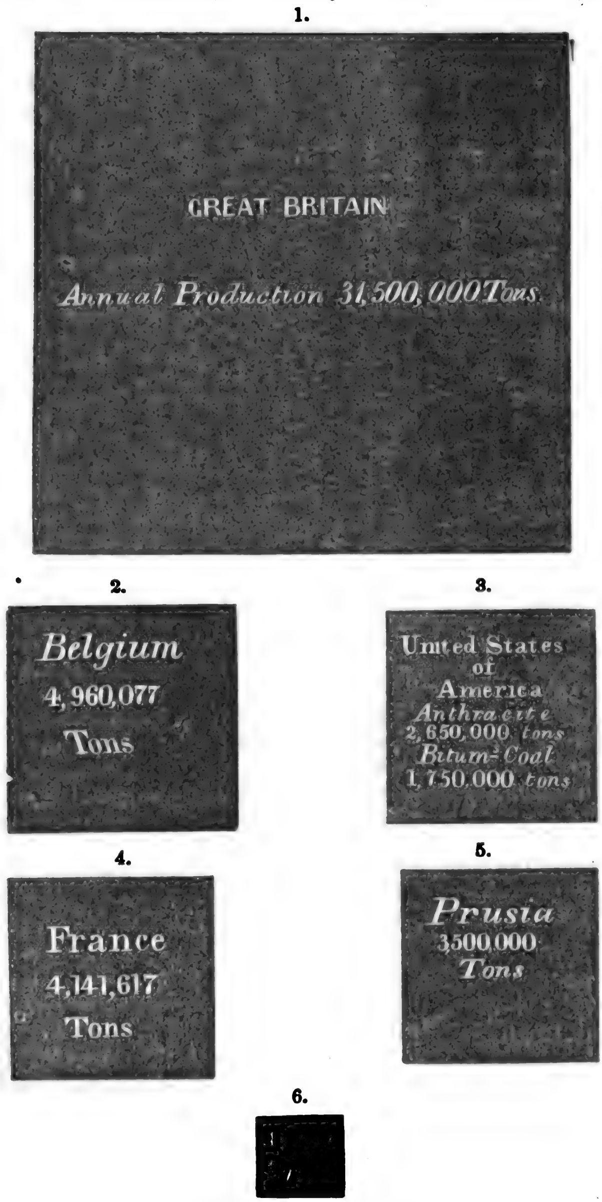
PRODUCTION OF COMBUSTIBLES.

Table of the Comparative Production of the Six Principal Coal Countries in the World, in the year 1845.—To enable us to exhibit the relative annual production and value of the coal, anthracite and lignite or brown coal, in the six great coal-producing countries of our globe, in the year 1845, which is the latest year in which we can now present a series of contemporaneous statistics, we have prepared the following illustrative statement. It is scarcely necessary to observe, that in the two succeeding years, up to the time of publishing this work, a regular increase has been simultaneously going on, in all the countries enumerated, and apparently at about a corresponding ratio. The present table shows the relative proportions, in each 1000 parts, yielded by each country, in 1845.

Order in 1845.	Countries.	Square miles of Coal Formations.	Tons of Fuel raised in the year 1845.	Relative parts of 1000.	Official estimated value at the places of production. United States Dollars.	English Sterling.
1	Great Britain,	11,859	31,500,000	642	$45,738,000	£9,450,000
2	Belgium,	518	4,960,077	101	7,689,900	1,660,000
3	United States,	133,132	4,400,000	89	6,650,000	1,373,963
4	France,	1,719	4,141,617	84	7,663,000	1,603,106
5	Prussian States,	not defined,	3,500,000	70	4,122,945	856,370
6	Austrian States,	do.	659,340	14	800,000	165,290
	Total,		49,161,034	1000	72,663,845	15,108,729

The accompanying diagram represents these proportionate results in a simple and intelligible form.

Diagrams of the relative amounts of production of Mineral Combustibles in the Six Principal Coal-producing Countries of the World, in the year 1845.



The returns of the production of coal during the years 1846 and 1847 have not all reached us: those received will be found under their appropriate heads.

Comparative ratio of Increased Production in Twenty Years.—It is a matter of very great statistical interest, in illustration of the condition of a highly important branch of industrial economy, to ascertain the actual progress which has simultaneously been made, in the demand for, and consequent consumption of, the mineral combustibles, during some years past. With a view to effect such a result, and thereby to indicate this progress in a comprehensive form, we have computed the contemporaneous advance, of five principal coal producing countries, during the space of twenty years prior to 1st January, 1846—that is to say from 1825 to 1845 inclusive. For a portion of these countries we have official returns for 1846, and even as late as 1847; but we are constrained to omit them in this table, because their insertion would prevent a just and accurate comparison with the rest; more especially as the latest years show a greatly accelerated ratio of increase. The following table exhibits the advance, *per centum*, during the twenty years aforesaid, in the mining countries named.

	Increase per cent. in twenty years.
I. Pennsylvania, production of anthracite only, that of bituminous coal being unknown,	5654
II. Great Britain, the production and general consumption are not registered.	
Exports to foreign countries and British settlements abroad,	713
General shipments at the mines, for exportation and for home consumption,	97
Brought into the port of London,	83
III. Prussia, indigenous production,	124
IV. France, do. do.	181
V. Belgium, do. do.	111

Hence it appears that as regards the highest rate of increase, Pennsylvania far outstrips all her contemporaries of the old world within the common period of twenty years. It is to be regretted that no means exist for ascertaining the advance, made in her production, by Great Britain, during the same interval. The increase, whatever it may be, is well known to be considerable, and it certainly must bear some analogous proportion to the enlargement of the manufacturing departments. The home consumption of coals in South Wales alone is not less than 5,000,000 tons per annum. In our next table we shall pursue this subject of accelerated production yet more in detail.

Onward movement of the Coal Trade.—The purport of the following comprehensive statement is to show the advance, *per cent.*, in the production, the importation, the exportation, and the consumption, of mineral fuel in the principal countries of Europe and America. We have computed it, where practicable, during three periods; that is to say, during the ten, the fifteen, and the twenty-five years prior to 1846:—the first period being from 1835 to 1845, and the second from 1830 to 1845, and the third from 1820 to 1845 inclusive. The production of Great Britain cannot be exactly known and compared; we therefore merely exhibit the increase in relation to shipments, exports, consumption in London, &c.

Proportionate increase, per centum, of the Production, Importation, Exportation, and Consumption of Mineral Combustibles, in contemporaneous periods.

Countries.		Periods of years.	Indigenous Production.	Importation.	Exportation. increase.	Consumption. increase.
I. Pennsylvania,		10	254	dimin'd.	increasing.	
		15	1057		to Canada.	
II. Great Britain,	General ship'ts,	15	94			
		25	134	increase.		
	Port of London,	15		66		
		25		101		
	Foreign Exports,	15			401	
		25			904	
III. Austria,		10	90			
		15	410			
IV. France,		15	125	230		154
		25	284	688		370
V. Belgium,		10	71			
		15	95		148	48
		25			514	
VI. Prussia,		10	65	328	166	
		15	112	1126	220	
		25	154		777*	

It is scarcely necessary to remark, that these proportions bear no relation to the *amount* of production, &c., in any of the countries named; but, as already announced, they simply represent the comparative periodical progress made, per centum, in each of those countries. We have, in the foregoing tables, made our computations on the four epochs of ten, fifteen, twenty and twenty-five years; because, by such subdivision, we are enabled to illustrate more faithfully the contemporaneous increase than if the comparison had been limited to a single term.

We have now placed before the reader, in the most concentrated form of which the matter is susceptible, the means of judging, with perfect accuracy, of the wonderful increase in the mining and commercial disposition of mineral fuel that has taken place in our own times. We here observe, for instance, that in the fifteen years prior to 1846, Belgium increased 95 tons on every 100, in 1830; that Prussia added 112 to every 100; that France added 125 to every 100; and Austria's rate of increase was not less than 410 on each 100. The ratio of Great Britain cannot be pointed out, except that she increased her foreign exportation five-fold in the same space of time. But the most remarkable advance on record is in the case of Pennsylvania, where, on every 100 tons of coal produced in 1830, the absolute increase is represented by 1057 tons in 1845.

SUMMARY OF STATISTICS OF MINERAL FUEL.

The following pages contain a resumé of what we have elsewhere exhibited in detail; viz. of the entire range of our present knowledge, regarding the production, importation, exportation, and consumption of fossil fuel,

* This is the increased exportation to France only. That to Holland is greater.

within all the principal coal producing and coal consuming countries in the world; together with their periodical rates of increase down to the present time; derived from every official return accessible to us.

GREAT BRITAIN—*Increased General Production.*—Owing to the absence of official records, applying to the general production of the collieries throughout the United Kingdom, we are constrained to leave this as a matter of inference, from the results which we have to adduce. We know, however, that its rate of increase has been rapid, especially in all the manufacturing districts; probably even much more so than that of exportation.

Increased Shipments for Home and Foreign Consumption, from the Ports of Production.—From 4,365,000 tons in 1819, to 11,254,750 tons in 1845; being at the rate of 158 per cent. in twenty-six years. This quantity is supposed to be about one-third of the entire production of the United Kingdom. The *declared value* advanced from £145,943 in 1828, to £970,462 in 1845; or 569 per cent. in seventeen years.

Increased Exportation of Coal.—To the colonies and British possessions, from 71,000 tons in 1819, to 375,302 tons in 1845; or 428 per cent. in 26 years; to France, from 39,180 tons in 1825, to 647,967 tons in 1845, = 1561 per cent. in 20 years; do. from 24,800 tons in 1820, to 647,967 tons in 1845, = 2512 per cent. in 25 years; to Russia, 1450 per cent. in 25 years; do. 375 per cent. in 15 years; Denmark, 1800 per cent. in 15 years; Prussia, 1214 per cent. in 15 years; United States, 287 per cent. in 15 years; do. British and Colonial, 184 per cent. in 15 years; East Indies and Ceylon, 2025 per cent. in 15 years; British West Indies, 126 per cent. in 15 years; Germany, 417 per cent. in 14 years; Italy, 323 per cent. in 9 years. Increased number of British vessels laden with coal for foreign ports, in the six years from 1840 to 1846 inclusive, 142 per cent.

Increased Shipments from the Collieries of the North of England—viz. from the ports of Newcastle, Sunderland, and Stockton on Tees, for foreign and home consumption collectively.—From 820,620 tons in 1710, to 6,123,282 tons in 1842, = 646 per cent. in 132 years; from 2,985,560 tons in 1810, to 6,123,282 tons in 1842, = 151 per cent. in 32 years; from 3,160,956 tons in 1832, to 6,123,282 tons in 1842, = 93 per cent. in 10 years. For *home consumption*, 50 per cent. in 18 years, ending 1842.

For Foreign Consumption only.—From 157,014 tons in 1820, to 1,784,-988 tons in 1845, = 1036 per cent. in 25 years. In 1773, there were only 13 collieries in the Newcastle district, which number increased, in 1828, to 59, with an annual productive power of 8,123,922 tons. In 1844, this productive power was estimated at 13,000,000 tons, and the number of collieries had increased to 124, and of pits, to 192; besides 6 other collieries in other parts of the same field, and 300,000 tons which were superseded by the inland coal. The shipments of coal to foreign parts, from this district, has increased from 50,805 tons in 1810, to 1,784,988 tons in 1845; being at the rate of 3468 per cent. in 35 years.

Increased Importation of Coal into the port of London by Sea and Land.—From 1,667,301 tons in 1822, to 3,461,199 tons in 1845, = 108 per cent. in 23 years; from 300,000 tons in 1699, to 3,461,199 in 1845, = 1057 per cent. in 146 years; from 2,079,275 tons in 1830, to 3,461,199 tons in 1845, = 66 per cent. in 15 years.

Increased Foreign Shipments of Coal from Hull.—7,463 tons in 1833, to 42,789 tons in 1845, = 477 per cent. in 12 years. From Liverpool, 50,561 tons in 1833, to 123,456 tons in 1845, = 146 per cent. in 12 years.

SCOTLAND—Has a greatly increased *production* of coal, but for the same reason as in the case of England, we possess no precise returns of the aggregate. This enlarged production is, in great measure, applied to the purposes of home consumption, especially to the various departments of iron making, which has advanced with surprising rapidity since the discovery of the Black Band ore.

Exportation to Foreign parts increased from 31,940 tons, in 1828, to 229,513 tons, in 1845; equivalent to 617 per cent. in seventeen years. But the recent excess of production is mainly reserved for home use.

SOUTH WALES.—We have no returns in relation to the advanced production. Judging from the increased number and power of the Welsh iron works, the home consumption of coal must be greatly augmented. It has been asserted, in 1844, that one third of the iron consumed in the known world, is produced in the mineral basin of South Wales, and upwards of five million tons of coal are annually consumed in its manufacture, and for other purposes, within the coal-field.

Foreign Exports.—The exports of South Wales, in 1833, amounted to 24,981 tons. In 1845, four only of the principal ports exported 237,577 tons. The entire increase, probably, does not fall short of 1000 per cent. in twelve years.

Shipments to London—Increased from 34,000 tons, in 1828, to 81,725 tons, in 1843, or 172 per cent. in fifteen years.

Increased General Shipments for Home and Foreign consumption.—From 904,896 tons, in 1828, to 1,700,000 tons, in 1841, = 88 per cent. in thirteen years.

The shipments, therefore, do not keep pace with the home consumption required for the iron works, &c.

FRANCE.—*Increased Indigenous Production of Coal, Anthracite and Lignite, in 29 years.*—From 869,410 tons, in 1815, to 3,639,446 tons, in 1843, the ratio is 203 per cent.

Table of the relative Increased Production of Mineral Combustibles in France; representing the production in 1787 as 1.00.

Years. Date.	Fuel, Tons.	Time, Years.	Proportion.
1787	212,910		1.00
1820	1,078,560	33	4.06
1830	1,836,950	43	7.62
1840	2,960,015	53	12.89
1843	3,639,446	56	16.09
1845	4,141,617	58	19.45

Increased value of Indigenous Production in France, in 28 and 31 years.

	In 1814.	In 1842.	In 1845.
Value in Francs,	6,082,447	33,497,779	39,705,432
" U. S. Dolls.,	1,316,950	6,476,237	7,663,000
" Engl. Sterling,	272,097	1,352,472	1,603,106

Increased ratio of value in 28 years = 397 per cent.: in 31 years, 489 per cent.

Increased Importation of Mineral Fuel into France, since 1820.

	Imported in 1820, Tons.		In 1845. Tons.		Per cent. in 25 years.
From Great Britain to France,	24,800	to	647,967	=	2512
From Belgium "	224,100	to	1,376,100	=	514
From Prussia "	27,500	to	237,200	=	762
Total imported into France,	276,400	to	2,116,272	=	665

And an increase on the total importation, since 1802, of 1756 per cent. in 43 years.

Ratio of increased Consumptian of Mineral Combustibles in France—Distinguishing the indigenous fuel from the indigenous and imported combined, in the periods of thirty and fifty-eight years, prior to 1846.

Dates.	Indigenous only.			General Consumption.	
	Tons.	Periods of years.	Increase per cent.	Tons.	Increase per cent.
1787	212,910			399,130	
1815	869,410	30	375	1,096,820	470
1845	4,141,617	58	1853	6,251,790	1467

BELGIUM.—*Increased number of Coal-pits in operation or in construction.*—From 314 pits or points of extraction, in 1830, to 660 in 1840.

Number of Miners increased from 29,253 in 1830, to 38,490 in 1844.

Production.—Within about thirty years there have been one or two periods of ebb and flow. Thus, from 1802 with 2,635,000 tons, to 1832, it was *reduced* to 2,249,000 tons, or 17 per cent. decrease in thirty years; and from 2,249,000 tons in 1832, *increased* to 4,960,077 in 1845, or 120 per cent. gain in thirteen years.

The increased *value* in the same interval being from 16,957,500 francs in 1832, to 55,400,000 francs in 1840, or 226 per cent. in eight years.

Increased annual production in the Belgian Provinces,	Liege,	1830 to 1845,	537,100 tons.
	Hainault,	" "	1,757,346 "
	Namur,	" "	111,873 "

Total increase from 2,553,000 tons in 1830, to 4,960,000 tons in 1845, or 94 per cent. in fifteen years.

Increased Importation from Great Britain.—From 770 tons in 1831, to 36,440 in 1841, and about 20,000 tons in 1847. The import trade, being of subordinate importance, was reduced to only 11,071 tons from England, and about the same quantity from France, in the year prior to 1847.

The manufacture of iron has advanced so rapidly that there were more tons produced from the furnaces of a single province, Hainault, in 1846, than in the entire kingdom of Belgium, only five years before.

Increased Exportation of Bituminous Coal from Belgium, chiefly to France.—Advance from 621,560 tons in 1830, to 1,356,973 in 1846, = 118 per cent. in sixteen years. Upwards of 1,700,000 tons in 1847.

In the fifty-eight years from 1787 to 1845, the exportation of coal from Belgium into France increased twenty-seven fold; or 2708 per cent. That to the Low Countries, in the seven years between 1835 and 1842, advanced nineteen fold. To other countries no advance.

Increased annual Consumption of Coal in Belgium.—Advance from 2,162,000 tons in 1830, to 2,670,000 in 1840. The domestic consumption in 1847 was probably upwards of 4,000,000 tons.

Holland.—The quantity of coal received from England has increased sixty-seven per cent. in the ten years between 1831 and 1841, since which it has diminishsd forty-eight per cent. in 1845.

That from Belgium has augmented 1940 per cent. in the seven years from 1835 to 1842. There is a large increase from the Prussian provinces.

Kingdom of Prussia.—*Increased Importation of Bituminous Coal.*—Advance, 154 per cent. in twenty-six years; from 1832 to 1844, 112 per cent. in twelve years.

Increased Importation of Coal from England.—From 15,956 tons in 1831, to 184,487 tons in 1845, about ten fold, or 1050 per cent., in fourteen years.

Rhenish Provinces of Prussia.—*Exportation to France.*—From 27,500 tons in 1820, to 237,200 in 1845; 777 per cent. increase in 25 years.

In the fifty-eight years from 1787 to 1845, the exportation into France advanced twenty-three fold, or 2322 per cent. increase.

Increased production of bituminous Coal in the provinces of the Lower Rhone.—Saarbrück.—From 233,000 English tons in 1817, to 700,000 tons in 1844, = 200 per cent. in twenty-seven years.

Westphalia.—*Increased production of Coal.*—From 370,268 English tons in 1819, to 1,200,000 tons in 1844, = 224 per cent.

Prussian Silesia.—*Increased production of bituminous Coal.*—From 285,000 English tons in 1817, to 850,000 tons in 1844, = 200 per cent. in twenty-seven years.

Prussian Saxony—Has doubled her production in twenty-one years.

Hanse Towns.—*Increased Importation of Coal from Great Britain.*—From 26,500 tons in 1789, to 227,539 tons in 1845, = 759 per cent. in fifty-six years. See Zollverein.

Denmark.—*Increased Importation from Great Britain.*—From 61,392 tons in 1828, to 168,153 tons in 1845, = 170 per cent. in seventeen years.

Norway.—*Increased Importation of bituminous Coal from England.*—From 3771 tons in 1831, to 15,894 tons in 1841.

Sweden.—*From Great Britain.*—Increase from 6150 tons in 1831, to 26,941 tons in 1841.

Russia.—*Increased Importation of bituminous Coal from England.*—

From 42,061 tons	in 1835,	to 150,422 tons	in 1845,	= 257 per cent.		
" 2,316 "	1810,	"	"	"	=1150 do.	in 25 years.
	1820	"	"	"	=7400 do.	in 28 years.

Hungary.—*Increased production of bituminous Coal.*—From 1823 (average of ten years) 14,500 tons, to 33,076 tons in 1845; 207 per cent. in twenty-three years.

Bohemia.—*Increased consumption of Coal in Prague in ten years.*—From 10,000 French tonnes in 1830, to 24,000 in 1839.

Production.—Advanced from 122,000 tons in 1832, to 340,000 tons in 1845, = 170 per cent. in thirteen years.

Austria.—Increased production of coal in the empire, from 1838 to 1846, 216 per cent.

Increased consumption of Coal in Vienna in ten years.—From 3000 French tonnes in 1830, to 10,000 in 1839.

Upper and Lower Austria increased production 47 per cent. in four years, from 1830 to 1834.

Increased *production* of combustibles in the Austrian Empire, from 209,000 tons in 1832, to 700,000 tons in 1846, = 234 per cent. in 14 years.

German States.—Prussian or German Custom-house League—The *Deutsche Zollverein.*—Increased *importation* from Great Britain, from 44,033 tons in 1831, to 227,539 tons in 1845, being 417 per cent. in fourteen years.

General exportation from the Zollverein.—218,440 tons in 1834, to 349,150 tons in 1843, being 60 per cent. in nine years.

General movement of coals in the states of the German Association.—from 282,760 tons in 1834, to 605,900 in 1843, = 111 per cent. of increase, in nine years.

Spain.—Notwithstanding our inability to illustrate with precision the mining statistics of Spain, we must not overlook the fact that it seems destined to become one of the most valuable of the continental coal-producing countries. In superficial area, the Asturian coal-field is probably not exceeded by any other on the continent, and as regards the number and quality of its coal seams, it is no less distinguished, although it is one of the latest brought into operation.

Great expectations have been formed as to the national value of this district, and much enterprise has already been attracted to the development of its important mineral resources; especially those of bituminous coal and iron ore.

The coal business is comparatively in its infancy, but promises a rapid progress in future. Thus the amount shipped coastwise from the Port of Gijon, in 1842, was 14,100 tons, and in 1844 was 41,400 tons.

United States of America.—*Imported Coal.*—The only countries from which coal ever finds its way into the United States, are Great Britain and British America, and the contributions from thence appear to be annually diminishing. For a time there was an increasing foreign importation; viz: from 22,123 tons in 1821, to 181,551 tons in 1839. By the operation of the American tariff, this advance was not only checked, but a retrograde movement was produced, so as in 1843 to amount to only 41,163 tons, by the United States returns. By the last annual return, that for 1847, the entry of foreign coals, whether from Europe or from British America, was 148,021 tons; of which from 12,000 to 15,000 tons were re-exported, for the service of the English steam ships.

INCREASED PRODUCTION OF AMERICAN COAL AND ANTHRACITE.

Bituminous Coal.—We have already indicated that we possess no authentic data for determining the progressive production of this description of fuel, in the United States. Such informal details as have reached us, will appear in the proper place; and we can only remark here that the rate of increase is evidently very rapid.

Anthracite.—Of this important combustible we shall have much to say, and we possess abundant testimony upon which to found our calculations. The production of anthracite may be said to be entirely confined to the state of Pennsylvania, which possesses a numerous and interesting group of coal basins, of various sizes and characters.

Our returns show that the consumption of anthracite,—in other words, the coal trade,—commenced with 365 tons in the year 1820; that the production reached 48,047 tons in 1827; that it had increased to 881,026 tons in 1837, and advanced to three millions of tons in 1847; without including much that is consumed on the spot, in the mining districts, or in the interior of the country.

The increased production, therefore, was, in the first ten years, viz: from 1827 to 1837, 1735 per cent.; in the second ten years, viz: from 1837 to 1847, 240 per cent.; and in the twenty years previous to 1848, that is, from 1827 to 1847, 6150 per cent.

We introduce another view of this subject, which exhibits this accelerated increase in the consumption of anthracite, perhaps, with yet greater perspicuity. The amount which was periodically forwarded to market, exclusive of the consumption in and near the places of production and which has not been estimated, is as follows:

Aggregate in the 21 years from 1820 to 1840, inclusive,	6,847,172	tons.
In the succeeding 7 years to 1847, inclusive,	12,371,961	"
Total furnished from the commencement,	19,219,133	tons.

With this we terminate our compendium of the coal statistics, into whose details we shall enter at large further on: our immediate object being that of showing the rapid increase in the annual production of coal, all over the globe, within the last quarter of a century.

PRODUCTION OF IRON.

We have already exhibited in the diagram form, the superficial areas of the principal coal producing countries of the world, and also the squares of the coal production of the same countries, in the year 1845. We are induced to occupy a small space here, by a similar mode of illustration in regard to the production of iron, in the same year, by the chief manufacturing countries.

In the preparation of the materials forming this volume, we never contemplated to devote any part of it to the subject of iron. The statistics of coal, which we undertook to elucidate, seemed to promise a task of quite sufficient magnitude to keep us in full occupation. Nevertheless, we have found that the rapid advancement of the coal trade was so intimately connected with the contemporaneous process of the iron manufacture, that we have, almost unconsciously, been led out of our prescribed path; and having collected some interesting results by the way, we give them insertion in their appropriate places.

We now only propose in this place, to introduce a *diagram* showing the condition, as to production, of the iron manufactory or smelting, in the year 1845, the latest year in which we could obtain a series of contemporary returns.

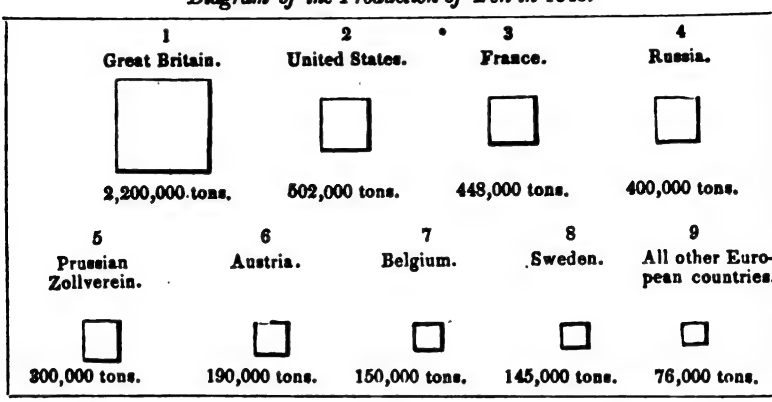
The respective proportions are as follows:*—

1. Great Britain, - - - . -	2,200,000
2. United States, - - - - -	502,000
3. France, - - - - - -	448,000

* See table of annual production of pig and cast iron in the principal iron manufacturing countries, at page 331 of this volume. By some accident the descriptive part of the diagram, which we have given above, was omitted there.

4.	Russia,	400,000
5.	Zollverein, or Prussian States,	300,000
6.	Austria,	190·000
7.	Belgium,	150,000
8.	Sweden,	145,000
9.	Spain, (1841)	26,000
10.	All other European countries,	50,000
	Total,	4,411,000

Diagram of the Production of Iron in 1845.



RAILROADS.

After passing from coal to iron, we are almost unavoidably tempted to diverge yet further, to the subject of railoads, steam engines and steam vessels,—so closely do all these matters seem interwoven with each other, being, at one and the same time, both cause and effect, in relation to the enormous increase of coal production, in all parts of the world. Thus we are impelled to notice the astonishing extension of railroads in our day, whereby the coal, the iron, and the other minerals, have become more generally accessible, and consequently more valuable, in proportion as they can be transported with cheapness and rapidity to their several markets.

The following statement shows the actual number of miles of railway finished and in progress in Europe and America in 1844.

	Miles.
In Great Britain and Ireland,	2069
In Prussia and Germany,	2500
In France 1241 *miles finished,*	1750
In Russia,	1500
In the United States of America,	3688
	11,507

In *England*, in 1845, there were obtained from Parliament new railroad acts for 3543 miles; up to 1846, the total number of miles authorized to be made in Great Britain was 7494 miles,* and to January 1st, 1847, 8384 miles, besides 1862 miles already made.

* For further details see page 328.

In *France*, in the same year, the number of miles completed, commenced, and proposed, was 3874,—whose estimated cost was $297,220,000, or £61,600,000.

In *Belgium*, there were 282 miles of railroad in operation in 1842; 348 miles in 1844, and 386¼ miles in 1846,—costing £5,789,872.

In the *Zollverein*, there were completed 24 railroads in 1843, of the length of 1730¾ miles.

In all *Germany*, in 1844, 3565 English miles, in 43 railroads.

United States of America.—By an unofficial article, dated June, 1846, it appears that there were then in operation in the United States an aggregate length of 4731 miles, which was constructed at the cost of $127,417,758, equivalent to £26,325,983.

From the data furnished up to that time, we collect that the capital invested in railroads alone, independent of private and local undertakings, had augmented nearly five-fold in ten years.

During the year 1846, the total amount of completed railroads in the United States had reached the aggregate of 4864½ miles.

In the beginning of 1847, there were, according to the report of the postmaster-general, of finished railroads 4752 miles; in progress and projected, 264 miles; total 5016 miles. Omitting the gigantic project of the Oregon railroad.

Thus, at the commencement of 1847, we find that the number of miles of completed and partly finished railroad in the principal countries of Europe and America, amounted to no less than 20,000 miles; being within a few thousand miles of the entire circumference of the globe. Those in Europe were supposed to require 6,157,000 tons of iron. Added to this, the government of British India has had surveys undertaken for 2000 miles of railroad, with a view of commencing a general system of railway in that extended empire.

Steam engines employed for purposes of industry, and also in mining enterprise, exclusive of that employed in navigation and locomotives.

Years.	France.		Belgium.		Years.	G. Britain.	France.		Belgium.	
	Fixed steam engines.	Horse power.	Fixed steam engines.	Horse power.		Newcastle or north of England coal-field. Horse pow.	Fixed steam engines.	Horse power.	Fixed steam engines.	Horse power.
1835	946	14,061			1840				1,049	26,056
1837	1,842	24,144	662	19,456	1843	19,397	2,595	35,197		
1838	2,332	27,677	1,044	25,312¼	1844	Cornwall.	3,645	45,781	1,448	37,370
1839	2,459	33,308	1,044	35,512	1845	44,000	4,114	50,188		

Hence, it is shown that the amount of horse power employed in mining and manufacturing enterprise in France increased 257 per cent. in ten years; and in Belgium 94 per cent. in only five years. Our English returns are incomplete.

Steam vessels of Great Britain, the United States, France, and Russia, chiefly engaged in Commerce.

Great Britain, exclusive of her Colonies.	Years.	No.	Tonnage.	Horse power.	Guns.
In 1814, only one steamboat in the British Empire.					
Merchant marine, - - - - - -	1833	386			
	1835	554			
	1837	620	69,800		
	1840	810			
	1844	900	114,000	70,000	
	1845	916	118,772		
	1846	1,000			
War steamers in commission, and building mail steamers, Indian navy - - - - - -	1846	179 134			688 310
United States.					
The first western steamboat was launched at Pittsburg, on the Ohio, by Fulton, in 1811.					
Internal navigation, - - - - - -	1840	800	155,473	57,017	
Coasting merchant marine,* sailing vessels,	1844		265,269		
" " "	1845		319,527		
Steamboats on the Western waters alone, -	1846	1,500	145,311		
" Lakes, - - - - -	"	80	54,486		
" "	1847	86	60,825		
Sailing tonnage on " - - - - - †	"		46,011		
Locomotive engines, - - - - - -	1840	350		6,980	
War steamers, - - - - - - - - -	1846	11			
Exclusive of 13 sailing and 8 steamers, having 61 guns, and revenue vessels, - - - - - -	1847	13			
France.					
Steamboats, - - - - - - - - - -	1833	75	3,800	2,633	
" "	1835	100	12,100	3,863	
" "	1837	124	19,900	5,408	
" "	1840	225		11,422	
" "	1844	238		12,789	
" "	1845	247		13,250	
" " ‡	1846	259			
War steamers in commission, and building, -	"	68			436
" " "	1847	66		14,570	
Russia.					
War steamers, - - - - - - - -	1847	32			

Such are the results which our recent investigations have disclosed, while seeking to trace the onward march of productive industry, in opposite hemispheres. However rapid may have been that advance in the Old World, in energy and perseverance—in inventive genius and mechanical skill—in an extended application of the useful arts—in the employment of mighty agencies known to us but as yesterday—and, above all, perhaps, in the adaptation of the wonderful powers of steam—the New World has by no means suffered herself to be left behind. It is but justice to the latter to show how fully she appreciates and avails herself of this newly acquired knowledge, by her rapid advancement in the operative and industrial arts, in so wide a field for human enterprise. We cannot perform this duty so efficiently as in the language of one of her own citizens and most distinguished engineers. The admirable and truly eloquent address, from which we take the following extract, was delivered at the successful termination of one of the most im-

* Merchants' Magazine, February, 1846.
† Official Report of the Sec. of the Treasury, 1847.
‡ Report of the Societé Maritime, 1846.

portant undertakings in the system of internal improvements in Pennsylvania. It reached us soon after we had embodied in the preceding pages the statistical results which were elicited during the preparation of the present volume.*

"We have already alluded to the indications which past experience affords of the probable future consumption of coal in this country. The subject is of primary interest, and we may, therefore, venture still to add some reflections upon the causes which are now at work to extend this consumption.

"In estimating the probable growth of this trade, we must, to some extent, endeavor to free our minds from the shackles of old opinions, and the influence of ancient example. We must learn to feel the truth, that we live in an age which bears little resemblance to the past, and the progress of which cannot be safely judged by the history of the past.

"This is essentially the age of commerce and of steam—the foundations of which are our *coal mines*.

"In the machine-shop and factory—on the railroad and canal—on the rivers and the ocean—it is STEAM that is henceforth to perform the labor, overcome resistance, and vanquish space. And it is not for human intellect to assign a limit to the application of this power, in a country like that which it is our fortunate lot to inhabit—intersected by noble rivers, and penetrated by numerous bays—with an extensive sea-board, lined by flourishing cities, and possessing, along with boundless enterprise, all the elements of national wealth.

"But, look where we will, the evidence of the truth that we live in an age of which the progress is not to be measured by examples from the history of the past, is prominent before us.

"Taking the iron trade as an example, we find that the mere increase of the production of this metal, in the valley of the Schuylkill alone, during the last eighteen months, exceeds the entire production of the furnaces of Great Britain, ninety years ago. The manufacture of cotton in Great Britain, which has increased about one hundred fold in the last seventy years, and of the same, and many other articles, as well in Europe as in this country, exhibits results almost equally striking.

"There was, in fact, no appreciable iron trade, and, indeed, but little trade at all, in the present ordinary use of that word, anterior to the introduction of the steam engine—an instrument of power deriving its efficiency almost entirely from coal, which, through its agency, has given birth to modern commerce, to modern enterprise, and a mighty impulse, too, to modern civilization.

"A quarter of a century ago—within the memory of almost all here present—those magnificent boats which now give life to the Delaware and the Hudson—the seven or eight hundred which traverse the Mississippi—and the thousand which circulate on other waters of this country, had no existence, except, perhaps, in the imaginations of those who were then considered wild and visionary enthusiasts. Now, every year brings forth new specimens, each in its turn regarded as the noblest creation of bold invention; and each week presents some new enterprise, by which the Atlantic cities are brought into closer connection with each other, and with foreign ports.

"The use of this power on the ocean has but just commenced; yet enough has already been accomplished to point to an approaching revolution in the

* Report to the stockholders of the Schuylkill Navigation Company, by Charles Ellet, Esq., President, January 4th, 1847.

coasting trade and foreign commerce of all countries. The next year promises to witness new lines of ocean steamers, connecting this country with England, France, Germany, and South America, and traversing the coast from New York to New Orleans.

"A quarter of a century ago, and there were not more than a thousand tons of anthracite annually raised and exported in all this Union; now the *increase alone* is more than a thousand tons per diem, and compounding rapidly upon that.

"But still we can form no accurate estimate of the future increase from the past. New elements are daily introduced into the problem, of which no human intellect can determine the value.

"The introduction of the railway system over all Europe and even Asia —over this continent and the West India Islands—over Russia, and even into the Papal States, offer a guarantee of a future consumption of iron and coal, and all the chief mineral products of the earth, to which no bounds can be assigned.

"Each railway requires iron for its track, engines, cars, and frequently for its stations. Each new steamer requires coal to drive it—iron for its engine, and sometimes for its hull—and five tons of coal for each ton of iron it consumes.

"Every steam boat that is launched, and every road that is forced into the interior, gives birth to new enterprise, new wants, and new commerce.

"The manufacture of the iron, and the propulsion of the machinery, require *coal*; the quantity increases with the expansion of the railway system; the system extends the area of civilized population, and consequent agricultural wealth. This wealth needs transportation, and this transportation again needs coal and iron.

"In this country, peculiarly, the consumption of this fuel is increasing with the general increase of population where it is employed—with the wider area over which it is used—with each new purpose to which it is applied—with the growth of every description of manufacture requiring power—with every new improvement by which the cost of its conveyance is diminished, and with the extension of inland, coast, and ocean navigation."*

Thus far has been exhibited in the foregoing pages an interesting picture of the wonderful advance made, in our day, in the application of the mineral combustibles. We have seen, and let us note the fact, that this enormous advance has not been limited to a single district, but that it has simultaneously proceeded in all the coal-producing countries of the earth. Doubtless a very large portion of this is ascribable to the prodigious extension of steam power, occasioning a corresponding demand for mineral combustibles. We should exceed our prescribed limits were we to adduce the evidences of this increased application of steam, through the agency of coal. Nor, indeed, is it essential to our purpose. But we are quite sure that we cannot more appropriately terminate this introductory section, than by citing the following expressive passage, which we find in the Bulletin of the Central Commission of Statistics in the kingdom of Belgium; to the author of which we have here to acknowledge our obligations.

"Industry has undergone a complete transformation since the establish-

* The power thus convertible to the purpose of lightening the labour of man was felicitously illustrated by Sir I. F. W. Herschel, in the remark that the ascent of Mount Blanc from Chamouni is considered, and with justice, as the most toilsome feat that a strong man can execute in two days. The combustion of two pounds of coal would place him on the summit.

ment of machinery. The development of mechanism is owing to the application of steam as the moving power. Steam has been substituted, in a multitude of operations, for the natural agents. If we had to write the history of industry, we should represent man seeking at first to direct, to his advantage, the elements of nature, and subsequently creating new forces and more powerful agents. In the first period, man finds masters in every thing which surrounds him; the means at his disposal are very confined; his knowledge and his capital are limited; regulations badly conceived; the small extension of outlets; the difficulties of transportation;—all restrain his capability of production.

"In the second period, the state of affairs changes: he has subdued the natural elements; he disposes them at his will; the science of mechanics procures him the most powerful agents; natural philosophy, chemistry, discover to him a part of their treasures; capitals are no longer locked up; the slender profits of agriculture impel them back towards industrial occupations. Interior shackles have disappeared; treaties of commerce establish, between the people, fixed relations, which daily enlarge their social and political connections. Distances are effaced; routes are multiplied; and steam, after having ploughed the rivers and the seas, skims the earth in a rapid flight. Commerce unites together every people; the market is enlarged. Production, which outstrips all local necessities, urgently demands new outlets: embarrassment no longer attaches to production; the trouble henceforth rests in the distribution.

"The employment of the combustible mineral, COAL, in the smelting of iron, has emancipated the IRON manufactory. Henceforward the mineral comes to seek the fuel. Steam is prepared as the motive power: the forgemaster, the founder, are no longer confined to the banks of rivers, or the depths of the forests, far from the inhabited places. Industry has broken her fetters; commerce is set free, at least in the interior. Gigantic high-furnaces arise; forges, bar-iron works multiply; iron receives every shape; manufactories fill the world with machines. One might even say that each operation of industry gives birth to new marvels, and that all contribute to the successive and unbounded enlargement of productive forces and of new agents.

"Thus, coal produces steam; steam fashions the metals which serve to fabricate the machines. The implements of various trades, leaving the workshops, are distributed through every branch of industry. Steam becomes the universal agent; if she is the producer, she is at the same time the vehicle of production.*

"The powers of man are centupled; he is no longer the serf of the creation; he is rather the king. The barons of feudality have made room, by their side, for the nobility produced by industry. The sword commands no more; it is capital which commands. To the state of strife, of warlike antagonism, succeeds a regime of industrial competition and of exchanges. Men know themselves and each other better; national characteristics are obliterated; it seems that humanity is invested with a new form; organization is established between states; between continents."

* "It is as yesterday only, so to say, that steam has been employed as a moving power; and yet it already furnishes the globe with a force estimated at more than ten millions of horses, or *sixty millions of men*." M. Michel Chevalier.

We would here refer to an excellent article in Hunt's Merchants' Magazine, June, 1846, by Mr. C. Frazer, on "The Moral Influence of Steam."

"Mineral and metallurgic industry is, with agriculture, the most vital element of our country's prosperity. Coal is the most essential agent of all industry; the foundry, the iron, constitute merely the instruments, the elements of riches."*

SECTION II.

MISCELLANEOUS NOTES IN RELATION TO COAL.

Terms of synonymous signification, many of which are employed in this work.

English, Coal, Pit Coal, Brown Coal, Sea Coal, Stone Coal; Collier, a coal miner; Colliery, a coal mine. *Saxon*, Col. *Dutch*, Koolen, Steenkull, Steenkoolen. *German*, Kohlen, Steenkohle, Schwarz Kohle, Pech Kohle, Kannelkohle, Moor Kohle, Blatter Kohle. *Danish*, Kul. *Swedish*, Kohl, Stenkol. *Cornish*, Kolon. *Irish*, Guel. *French*, Houille, Charbon-de-terre. *Belgic*, Houille, Houillieres, coal pits. *Italian*, Carboni Fossili. *Latin*, and *Greek*, Lith-anthrax. *Portuguese*, Carvoes de terra, ou de Pedra. *Russian*, Ugolj, Kamennoe. *Spanish*, Carbon de tierra, Rock coal; Carbon de Piedra, Stone coal. *Welsh*, Culm. *Swedish*, Kolm.

English, Charcoal, carbonized wood. *Italian*, Carbone di legna. Carbo ligni. *French*, Charbon de bois. *German*, Reine Kohle. *Spanish*, Carbon de lena.

English, Pitch. *German*, Pech. *French*, Poix.

English, Jet. *German*, Jayet.

English, Coke. *Swedish*, Stenkolstybb. *French*, Charbon de terre, Charbon de bois. *English*, Charcoal. *German*, Kohlenstoff.

Irish, Peat. *Scotch*, Peat. *English*, Turf. *German*, Torf. *French*, Tourbe, Tourbiere. *English*, Turbary. *New England, U. S.*, Tug.

GEOGRAPHICAL DISTRIBUTION OF COAL.

In his 25th chapter of the "History of Fossil Fuel," the author dilates on the influence which future discoveries of deposits of coal in foreign countries and the increased employment of the combustibles in manufactures there might have upon the industrial operations and local interests of Great Britain. Inquiries of that sort would scarcely be expedient here, inasmuch as we do not advocate the exclusive interest of any country, and acknowledge no preference for the prosperity of one section to the disadvantage of its neighbour. We espouse no cause save that of economic geology and the useful arts associated with it; contemplating these subjects with reference to their practical benefits, to their commercial and productive value, present and prospective. We estimate them in proportion as they are interesting in science, and conducive to the well-doing of the mass. With

* Bulletin de la Commission Centrale de Statistique, Bruxelles, 1843.

such views we seek not to define how far the possession of local advantages, the discovery of new mineral deposits or of improved appliances and facilities, may retard or accelerate rival interests. It is not our purpose to inquire into the injury which particular establishments or regions might sustain when placed in a state of competition with others which happen to enjoy a more favourable state of circumstances.

Two great facts, beyond all, stand prominent. It is certain that as manufacturing and productive industry take root and flourish almost exclusively in the cool and temperate zones, so in them do the coal formations and all the most useful mineral productions prevail in their greatest abundance. Our scientific maps and investigations confirm the one, and national statistics determine the other. Hence, the climates which are most congenial to laborious occupations, the latitudes which are best adapted to the more energetic pursuits of man, are precisely those where, fortunately, have been placed beneath his feet the raw materials most essential to his use. At the same time, the process of acquiring those materials, forms, of itself, one of the most valuable sources of his prosperity.

Between the Arctic Circle and the Tropic of Cancer repose all the principal carboniferous formations of our planet. Some detached coal deposits, it is true, exist above and below those limits, but they appear, so far as we know, to be of limited extent. Many of these southern coal-fields are of doubtful geological age. A few are supposed to approximate to the class of true coals, as they are commonly styled; others are decidedly of the brown coal and tertiary period, while the remainder belong to various intermediate ages, or possess peculiar characters which render them of doubtful geological origin.

In the high northern latitudes it has for some time been known that a species of coal exists on both sides of Greenland, and more recently it has been determined at various points of the Arctic ocean, between Baffin's Bay, and Berhring's Straits. It is understood that the coal on the west coast of Greenland, and at Disco Island and Hasen Island is of the species denominated lignite, or the most recent of the mineral coals. Of the carboniferous formations discovered by the several exploring expeditions towards the North Pole, some are of the acknowledged brown coal age, others have been imperfectly examined and described, and may perhaps be of the same geological age as those enormously extended deposits which stretch through the central part of the American continent. The coals of Mellville Island and Byam Martin's Island certainly appear to be of the true coal period. We know that coal exists, at numerous intermediate points, from the 75th to the 27th degree of north latitude, in America, and also that it is worked on the Salado and Rio Grande rivers in Mexico, for the use of the steamers.

Southward of the Tropic of Cancer the existence of coal, corresponding with the European and American hard coals, is somewhat uncertain. There seems to be none on the South American continent, unless it be at Cerro Pasco,—which needs confirmation,—or in the province of Santa Catherina, in Brazil. On the African continent we have had vague accounts of coal in Ethiopia and at Mozambique, also in Madagascar, and quite recently we have had intelligence of large quantities of coal in the newly ceded territory above Port Natal on the eastern side of Africa, but we believe no geologist has examined those sites. In the Chinese and Birmese empires only brown coal appears to approach the tropic. Southward of the Asiatic continent we are uncertain of the exact character of the coal deposits, such as occur abundantly in Sumatra, Java, and Borneo, and neighbouring islands.

In New South Wales the great coal range on the eastern margin of that continent was formerly sometimes considered to be like the Newcastle coal in England, and sometimes it was thought to be only brown coal; and indeed it is very certain that lignite does exist there; but the recent investigations of Count Strzelecki suggest that the epoch of the principal coal formations of Australia and Van Diemen's Land approaches somewhat to the oolite period. This coal differs essentially from that of any known European formation, but bears a strong resemblance to the Burdwan coal of India.

We may mention here, incidentally, that good coal is not essentially limited to the carboniferous period of the European geologists, but may and does exist, of excellent quality, in formations both of older and later origin. The Richmond coal-field of America is now shown to be of an age not much, if any, anterior to the older oolite series. Mr. Lyell has observed that no estimate of the probable value of the coal of India can be formed by comparing it with coal of the same age in Europe. Sir Henry de la Beche has also remarked, that it was incorrect to suppose that in all other countries the most valuable coals would be found in rocks agreeing in age with the English coal measures. Those of Australia and Northern India, for instance, resemble each other in quality and in their fossil flora, yet both are dissimilar from those of the English coal-fields, and are evidently, like the Virginia coal alluded to, of an entirely different origin.

The evidence as to the facts contained in the foregoing sketch, will be found in detail in succeeding pages, and is especially illustrated by the map of the world, prepared for this volume. From what has already been stated, it will be seen that it is impracticable, in numerous instances, to announce the true place in the geological scale, of formations which pass under the common denomination of coal. In some of these cases they have received no scientific investigation, and in others the results, if ascertained at all, have not reached us.

Of course, we have not yet arrived at the period when we could pronounce with any approach to certainty, on the actual number of coal basins in the world. Were we to venture an opinion, we should rate the number at from two hundred and fifty to three hundred principal coal-fields, and many of these are subdivided, by the disturbed position of the strata into subordinate basins.

COMPARATIVE VALUE OF GOLD AND SILVER, AND OF COAL AND IRON.

A Spanish writer, not long since, instituted a comparison between the productive value of the silver and gold mines of America and that of the coal mines of England. The author exhibits a balance in favor of the latter of nearly two hundred and thirty millions of francs* = £9,286,000 sterling, annually.

Baron Humboldt, at the commencement of the nineteenth century, estimated the produce of the gold and silver in North and South America at	$43,500,000	
Which sum at the rate of 4*s.* 3*d.* a dollar amount† to		£9,233,750
Mr. Jacob estimated the annual value of the precious metals from the American mines, between the years 1800 and 1810, at	$,47,061,000	£10,000,000

* History of Fossil Fuel, p. 474. † McCulloch's Geographical Gazetteer, p. 80.

But from 1810 to 1829, the average annual production was only		£4,036,000
From thence to the present time the produce is certainly under	$24,000,000	£5,000,000
Exports of gold and silver from Mexico in 1842,*	$18,500,000	£3,850,000
An estimate has been recently made with regard to the production of the precious metals to the following effect: In 40 years, from 1790 to 1830, the production of Mexico, Chili, Buenos Ayres, and Russia, in gold and silver, £188,000,000 sterling, equivalent to an annual average of		£4,700,000
Sir H. T. De la Beche estimates the value of the coal at the pit's mouth in Great Britain,		£9,000,000
Others estimate it at		£9,450,000
Another estimate extends the value to†		£10,000,000
The produce of the British coal mines is variously calculated at from 31½ millions to 34 millions of tons. At the respective places of consumption, in manufactures, in domestic use and that exported,	$96,800,000	
The value is probably from £17½ millions to		£20,000,000
The capital employed in the coal trade is computed at 8 or 10 millions more,‡		£10,000,000
The value of the iron produced through the agency of this coal in Great Britain at the furnace,		£8,000,000
Value of the iron when manufactured, in its various branches, which of itself greatly exceeds the value of all the gold and silver of the new world, in the most productive times,	$82,280,000	£17,000,000
Or nearly five times that of the gold and silver of Mexico, in 1842.		
The yearly value of the coal in five principal coal countries of the world, viz: Great Britain, Belgium, France, Prussia and Pennsylvania at their respective places of consumption, we have computed to be,	$145,200,000	£30,000,000
Which is nearly nine times the annual value of the gold and silver exported from Mexico, or six times that of the gross produce of the precious metals in North and South America and Russia.		
In 1847, a statement has obtained extensive circulation, which rates the value of the gold and silver produced in the world at 339,334,000 francs,	$65,489,000	£13,710,407
The value of the coal produced in the same year, upwards of		£17,000,000

* Commerce and Resources of Mexico.—Hunt's Mag., vol. x., 1844, p. 121.

† McCulloch.

‡ Mr. Buddle, in 1829.

EMPLOYMENT OF MINERAL COMBUSTIBLES.

In Great Britain, coal, according to some authorities, was mentioned as occurring in *England* as early as the ninth century, A. D., 853. It was certainly known and applied to various economical purposes in the middle of the twelfth century. In 1239, King Henry III. granted the privilege of digging coals to the good men of Newcastle. But it is little more than two hundred and fifty years since coal came to be in general use, as fuel, in London. Upon its first introduction there, one or two ships were sufficient for the whole trade.* At the present day there are several thousand ships constantly engaged in the transportation of that combustible.

It appears, from a charter of Edward the Second, A. D. 1315, that the coal of Derbyshire was at that time known and in use. The introduction of coal for domestic purposes was retarded by the difficulty of employing it conveniently, and by the natural prejudice against such a description of fuel, as a substitute for wood, in cities.

By a proclamation of Edward the First, and again in the reign of Queen Elizabeth, we find that stone coal was prohibited in London during the sitting of Parliament, lest the health of the Knights of the Shire should suffer during their residence in the metropolis.

Blythe, an old agricultural author, writing in 1649, has the following passage:—"It was not many years since the famous city of London petitioned the Parliament of England against two anusances or offensive commodities, which were likely to come into great use and esteem: and that was, Newcastle coals, in regard of their stench, &c., and hops, in regard they would spoyle the taste of drinck, and endanger the people."

In France, the precise period of its adoption as a substitute for wood, is not ascertained: its introduction was probably very gradual. The commencement of its use in the city of Paris was in 1520, the coal being drawn not from the mines of France, but from the collieries of Newcastle. It would seem, however, that at the outset it met with little favour in Paris, as for some time was the case in London, doubtless owing to the difficulties attending its application. It was submitted to the decision of the faculty of medicine, in the former city, how far this new description of fuel was prejudicial to the public health. It was not probably before the middle of the sixteenth century that coal mining in France had commenced to be of any importance.†

In Scotland mineral coal was known, probably, much earlier than in France. The privilege of digging coal is mentioned in a grant to a religious house, A. D. 1291.‡

In Belgium, the earliest reference to mineral coal was in 1198 or 1200, in the country of Liege, where tradition gives the credit of the application, as a fuel, to a blacksmith. From this time there seems to be evidence of its being in ordinary use, and that the business of its extraction had, from a remote period, prior to the fifteenth century, been subject to the supervision of an especial court or jury.§

In these and some other countries, we have already shown the extraordinary accelerated demand for coal since the application of steam power; more especially within the last quarter of a century. We have also pointed

* Williams' Mineral Kingdom.

† Resumé des travaux statistiques, Paris, 1839.

‡ See many historical notes in the "History of Fossil Fuel."

§ Bulletin de la Commission centrale de Statisque, 1843, Brussels.

out the vast capital which this substance keeps in motion; the numerous population which it employs and sustains.

Great as has been the rate of advance in England, that of France and of Prussia, within the same time, has somewhat exceeded hers, while that of Pennsylvania, in the United States, has far surpassed them all.

The Tyne and Wear districts, in Northumberland, are the most remarkable instances of coal production in the world. They supply above six millions of tons annually; employ about 23,000 miners; support 140,000 persons in manual labour; and, with their families and dependents, sustain 700,000 individuals.

From *South Wales* we have received no recent returns of the annual quantity of bituminous coal and anthracite, or of the number of persons engaged in their production. The bulk of the former has always been consumed in iron making in the interior, besides a vast amount exported coastwise. Since the uses of anthracite have been made apparent, the consumption of that mineral has greatly increased. As far back as 1835, the making of bar iron in that region employed 28,000 persons.

The total number employed in England on this branch of manufactory was, at that time, near 70,000 persons; while the aggregate of persons dependent on these was upwards of 250,000. Proceeding to a more advanced stage in iron manufactures, it was announced that the value of the hardware and cutlery annually made, was above $82,280,000, giving employment to 325,000 persons. Hence, it appears, that the number of persons directly or indirectly drawing support from the production and employment of the two substances, iron and coal, amount, on a rough estimate, to a million and half of persons.

"It is hardly possible," says Mr. McCulloch, "to exaggerate the advantages England derives from her vast beds of coal. In this climate, fuel ranks among the necessaries of life; and it is to our coal mines that we owe abundant and cheap supplies of so indispensable an article. Our coal mines are the principal source and foundation of our manufacturing and commercial prosperity. Since the invention of the steam engine, coal has become of the highest importance as a moving power; and no nation, however favorably situated in other respects, not plentifully supplied with this mineral, need hope to rival those that are, in most branches of manufacturing industry. To what is the astonishing increase of Glasgow, Manchester, Birmingham, Leeds, Sheffield, &c., and the comparatively stationary, or declining state of Canterbury, Winchester, Salisbury, and other towns in the south of England, to be ascribed? The abundance of coal in the north, and its scarcity and consequent high price in the south, is the real cause of this striking discrepancy.

"Our coal mines have conferred a thousand times more real advantage on us than we have derived from the conquest of the Mogul Empire, or than we should have reaped from the dominions of Mexico and Peru. They have supplied our manufacturers and artisans with a power of unbounded energy, and easy control; and they have enabled them to overcome difficulties insurmountable by those to whom nature has been less liberal of her choicest gifts."*

Mineral Coal applied to Iron Making.—The earliest employment of this fuel in England, in the manufacture of iron, was in 1713, at Colebrookdale. In Scotland it was introduced about the middle of the eighteenth

* Statistics of the British Empire, vol. ii. p. 2.

century, and in France in 1782; in the coal field of Creusot. Numberless notes will be found in the pages of this volume, in illustration of this interesting subject.

GEOLOGICAL POSITION OF COAL BEDS.

"Coal is found in beds, and its presence characterizes, in an especial manner, the carboniferous formation. We have to seek it then, above the transition series and below the secondary deposits;—above the schistose beds, the insoluble clays and trilobite limestones; below the arenaceous deposits which contain the debris of porphyries, the limestones with ammonites, gryphites, belemnites, &c.

The coal formation is remarkable for the peculiar appearance (*facies*,) of its micaceous sandstones and its argillaceous shales. In the coal sandstones, the elements of feldspar and quartz, in very nearly equal proportions, spangled with mica in little scales, passing in the lower portions, into breccias and conglomerates with large fragments, are evidently the result of the action of the waters upon pre-existing transition rocks. The granites and gneiss have furnished the principal amount of these elements; and we can often determine the points from whence they have been drifted. The argillaceous schists, rarely soluble, but always falling to pieces in the air, form the passage of the transition argillaceous schists into the true clays of the posterior strata. They are evidently decomposed parts of the rocks which constitute the sandstones. An impure melange of kaolin, of silex and of mica, of which the elements, fine enough to have been held in suspension, were only deposited when the stagnation of the waters permitted. These beds alternate with a great predominance of the sandstones; all are frequently colored by the disseminated carbon, which gives to the ensemble a grey tint and a characteristic duskiness. The presence of the carbon manifests itself also by that of the carbonate of iron—*fer carbonaté lithoïde*—which is found, either in subordinate beds, or in disseminated nodules—*rognons*—in certain beds of clay. Finally, it manifests itself by numerous vegetable impressions, and by the frequent, but not essential, presence of seams of coal, sometimes fat and sometimes dry.

The influences which have determined the characters of the rocks that are associated with the coal beds, have been so constant, that not only are they identical all over the globe, but in the cases where coal beds are found in other formations than the coal formation, the rocks of those formations abandon their special characters to borrow those which we have described.

Thus, in the anthraxiferous formation, which immediately precedes the coal period, the lean coals which are worked in the west of France, are accompanied by feldspathic, micaceous sandstones, and carbonaceous schists, with impressions of calamites, ferns, and sigillariæ. Black argillaceous schists, with nodules of carbonate of iron, accompany equally the beds of secondary coal which are found in certain points of the lias near Milhau, (Aveyron) and in Yorkshire.

To sum up the various geognostic positions of coal: they are met with, 1st, In the anthraxiferous formation; that is to say, in the upper part of the transition series, even above the silurian beds. 2d. In the coal formation, properly speaking. 3d. In the marnes irisées, where are found the coals of Noroy and Gemonval. 4th. In the lias formation. [Environs of Milhau.]

Above this last position, the vegetable debris is found most generally in the state of lignites. We find, but rarely, in the lignites of the cretaceous

and tertiary formations, portions from which the ligneous texture has disappeared, and which present the appearance of coal; but this case is exceptional. Thus certain lignites in the environs of Marseilles, and others which exist in the tertiary beds of Italy, present the tissue and the characters of coal, but these accidental facts, which establish between the coals and the lignites mineralogical transitions that exist even between rocks the most distinct, strikes no blow at the rules of position, established undeniably by geological observations. It is the same with that other geognostic law which assigns peat solely to the alluvial epoch, or the actual existing epoch.

The meagre coals and anthracite appear, in general, to be of a more ancient age than the fat or flaming coals. This classification is sufficiently indicated by the general dry nature of the combustibles mined in the anthraxiferous formation of the west. In the north, the lean coals of Fresne, Vieux-Condé, Vicoigne, are evidently inferior to the fat beds of Anzin and Denain. The beds found in the carboniferous limestone at Château-l'Abbaye are true anthracites. The anthracites of the environs of Roanne, and those of the United States,* belong to the upper formation of the transition series. But it is necessary again, more than in the preceding cases, to abstain from taking this rule in an absolute manner; for the anthracite state is very often the metamorphic state of the coal, and even of the lignites. The interesting researches of M. Elie de Beaumont upon the anthracites of the Alpine regions have demonstrated this fact, otherwise easy to conceive."

From each of the four classes or epochs of combustibles, M. Régnault has selected the most characteristic, and after having submitted them to analysis, he has acknowledged that this general succession of characters in the fossil combustibles is in accordance with a successive approach towards the composition of the vegetation; in such manner that, from the anthracites of the transition series, even to the lignites and to the peat of the existing epoch, the fossil combustibles form a series of which almost pure carbon forms the base, and which is gradually charged with four, five and six per cent. of hydrogen, and with four, eight, twelve, sixteen, and thirty per cent. of oxygen.

We may lay down this principle, abstraction being made for the anomalies of metamorphism, that the more of gas that a combustible contains, and the higher the amount of oxygen and hydrogen, so much the more modern is the combustible.

LOCAL POSITION AND ARRANGEMENT OF BEDS OF COAL.

Coal, whatever may be the formation in which it is found, affects the form of *beds*, of very variable thickness and continuity, but whose constant character is that of conforming to all the courses [*allures*] of the beds of schist and carboniferous sandstones between which they are included. This stratification is not only indicated by the limits of the roof and the wall or floor, but also by natural variations in purity, the positions of which generally pursue or occupy lines parallel to those of the roof and floor; by the bands of

* Respecting the geological age of the anthracite of the United States, we think that there is good ground for dissenting from the views of M. Burat, in placing this carboniferous formation in the superior part of the transition series. It is true, the present writer formerly held and advocated precisely the same opinions, but subsequent investigations have clearly established the geological fact, that the Pennsylvania anthracites are simply in the metamorphic state; that they are based upon the old red sandstone, and that the numerous basins in which they are deposited are but isolated, or out-lying portions of the great bituminous coal-field of the Alleghany Mountains.

intercalated slate, and by the continuous *barres* which divide the beds into several courses. Finally, the coals themselves often present a great number of interruptions, and of veins which render its structure striped, lamellar, and following the direction of the stratification.

The stratification of coal ought not, however, to be considered as absolute, and to be compared to that of the calcareous or argillaceous beds of the sedimentary formations, nor even to that of the sandstones and shales which alternate with them. Certain beds present massive undulated forms, yet without these undulations having been occasioned by the course or strike of the formation. This shows that the origin of the coal permits, at one and the same time, thin layers, continuous and of the greatest regularity, and thick beds, so limited and irregular, that they may be assimilated to masses. The ulterior details, respecting the forms and courses of the principal coal deposits, will decide perfectly our ideas in this respect. The thin and regular beds, although very much disturbed, of the basins of the north of France and Belgium, and the thick and limited beds of Montchanin represent the two extremes of position.

The number of coal beds, in the same formation, as well as their thickness and continuity, appear to be subject to very great variations. Nevertheless, there is a certain connection between these different conditions. The thin and regular beds are commonly continuous and multiplied; the thick and unequal masses are, on the contrary, limited in their extent, and there are rarely more than two or three superposed in the formation which encloses them. Thus, in the basin of Mons, in Belgium, more than one hundred distinct seams of coal are counted, whose ordinary thickness varies from eight inches to near five feet. In the collieries of the department of the North, in France, there are few centres of exploitation which do not count six, eight, twelve, or more beds of coal; but their maximum thickness does not exceed three feet, and the greater part of those which are worked have only about twenty inches.

Although coal beds have frequently been traced along a distance of many miles, yet we ought not, even in the case of very great regularity, to suppose that certain beds of coal are absolutely coextensive with the whole formation. For example, there is an interruption between Valenciennes and the Belgian frontier, to such an extent that the beds of Anzin are not those of Mons, and these, again, have no relation of continuity with the beds of Liege or Charleroy. The same remarks can be applied to other coal basins. Thus, in the basin of the Loire, the beds of Rive-de-Gier, are not the same as those of Saint-Etienne. We may, then, in a basin of some extent, consider the coal as forming, within the beds of sandstones and shales, special districts; often isolated, the one from the other, by sterile portions, and of which the coal beds, differing in number and power, have no relation of continuity.

Although, then, even if we have discovered the sandstones and the shales of the coal formation, it does not follow that we have also found the coal, though we were on the prolongation, in direction or inclination, of known beds. To form a probable hypothesis on this subject, it would be necessary first to study the peculiar conditions of the formation on which to operate, and calculate, from the known portions, the chances that we may have.

The strata of the basin of the Saône-et-Loire appear to form basins subordinate to the principal basin, which is filled up with coal, sandstones and schists. These subordinate basins are bounded like the basin which contains them, and have, besides, nearly similar proportions between the axes.

Further, the coal appears there to diminish in length in proportion as it acquires thickness. In the valley of Creuzot, the great bed which is worked has twelve metres, or forty feet, of mean thickness. In the enlarged portions it has 40 metres, or 130 feet from wall to roof. In direction it is not prolonged above 2000 yards; and, with regard to its limits, its divided extremities, there impoverished, present all the symptoms of a total suppression.

The bed of Montchanin, greatly inclined, whose thickness attains even to 70 metres, or nearly 230 feet, measured from roof to floor, representing, consequently, the thickest known coal bed, is equally one of the most limited in extension. In fact, in the upper part of the exploitation, this direction is about 650 yards, at the end of which the bed terminates abruptly, and is confused or entangled in the rocks of the roof and floor. At a lower stage, about thirty yards below the first, the length is reduced to 450 yards, and it is probable that at the depth of about 150 yards the bed will terminate.

The basin of the Loire contains, in the region of Rive-de-Gier, but three beds, of which the average united thickness does not exceed 32 feet; but, in the district of Saint-Etienne, the sum of the regular beds amounts to 114 feet, in fifteen to eighteen beds. At Brassac they amount to from 27 to 40 feet; 45 feet at Comentry and Doyet; and 48 to 65 feet in the basin of Aubin. It is remarkable that, in all these basins, the coal beds, of 15 to 30 feet, are occasionally reduced, by contractions, to 6 or 10 feet, and at times are swelled out to the thickness of 60 to 90 feet, an ordinary and normal fact.

In the department of the North, on the contrary, 30 feet of total thickness are divided into 14 beds, worked at Fresne and Vieux-Condé. The 12 beds of Aniche only form 22 feet; four successive beds at Douchy have only 11 feet aggregate; at Denin 7½ feet only; and 38 feet are occupied by not less than eighteen beds at Anzin. There are also still more veins, which are unworked, and whose thickness is below one foot each. But these beds are regular and prolonged, and are not disturbed by those enlargements and entanglements so frequent in the beds of the southern basins.

This difference of power and continuity in the coal beds agrees also with some very important differences indicated by geological observation.

The southern basins of France appear to have been deposited, during the coal period, in isolated lakes of fresh water; encircled, and entirely commanded by the neighboring summits, from whence the materials have often been drifted with violence: forming breccias and conglomerates. In studying this debris, especially in the lower parts of the deposit, we can recognize the transition rocks of the surrounding countries. The northern basin of Belgium and France, containing at its base the carboniferous limestone, is, on the contrary, only composed of sandstones and fine schists. It appears, from the character of the fossils, to have been formed in marine waters, and thus represents, with the coal basins of England, the pelagic accumulations of an epoch, of which the basins of the south are but the lacustrine terminations. It is, then, natural to discover, in these northern deposits, a regular and continuous disposition which comports not with the deposits of the south.

The southern basins, deposited in isolated lakes of fresh water, form the principal riches of France. The aggregate thickness of the coal is, besides, nearly as great as in the basins of the north. To sum up all, we can lay down no absolute rule for the number and power of the beds of coal, any more than for their continuity. The indices, which result from the direction of the stratification, have, nevertheless, a real value, even in the coun-

tries where the continuity presents the most frequent exceptions; because they always conduct to the possibility of finding, if not the prolongation of the beds, at least to formations analogous to such as have been already discovered.

ACCIDENTS, FAULTS, AND IRREGULARITIES OF COAL BEDS.

The beds of coal are rarely in the position where they have been produced, for that position would approach sensibly to the horizontal; a condition compelled, if not by the mode of production of the coal itself, at least by that of the beds of sandstone and slates between which it is stratified. Most frequently, the uniformity of the formation is disturbed, not only by inclinations, more or less great, but also by the folds which change these inclinations, and distort the beds to such an extent that a vertical shaft might cut them several times. There often, also, prevails one or several systems of *faults* [*failles*] which change the levels and isolate, one from the other, the divers parts of a bed.

This *accidentation*, subsequent to the production of the beds, and resulting from dynamic perturbations, commonly influenced by determinable conditions of direction, must be distinguished from the contemporaneous accidents inherent even to the production of the coal; such as the undulations of the roof and floor, which swell or contract a bed, and the intercalations of layers or of amygdaloid rocks, which interrupt the regular order of the stratification. Nevertheless, there is an evident connection between these two causes of irregularities; because the dynamic perturbations appear to have sometimes operated upon the coal beds before they were solidified; or, at least, when they were in such a state, that they were capable of being compressed, squeezed, and even completely suppressed, by a compression between the rocks of the walls, and, consequently, enlarged at other points.

The distorted structure, often smooth and polished, of the shales which accompany the coal, thus troubled; the state of the coal itself, which is there not only more crushed than at other places, but sometimes twisted or contorted and in a manner kneaded, seem to confirm the existence of these almost contemporaneous perturbations.

We may, besides, by attentive observations, frequently distinguish the dynamic and violent perturbations of such as result even from the circumstances of the deposit. The regular seams [*nerfs*] of shale and their beds or bands [*barres*] of clay, which are almost always interposed in beds of coal, following the direction of the stratification, can furnish many indices in this respect. Thus, in a natural expansion, not only the seams (nerfs) and bands which exist, do not experience perturbations, but they add other parallels to the increasing thickness of the coal. A natural contraction is often produced by the dilatation of the "barres," and, at other times, the barres submit gradually, like the coal itself, to the influence of diminution. In the dynamic accidents, on the contrary, the "nerfs" and barres are broken suddenly, and their fragments, blended with the coal, announce, in advance, to the miner the accident which comes to modify the "allure" of the bed.

The accidents to which coal beds are subjected, are those of the *inclination*, the *folds*, the *faults*, the displacements and the disturbances.

Inclination is the most general casualty: it is rarely, in fact, that the seams are presented in a horizontal position. These inclinations are evidently the result of perturbations, of upheavings or of sinkings of the earth, subsequently to the deposit of the formation.

The direction of all the beds is commonly the same in a coal basin, but their inclination varies. Thus, it is remarked that, upon the opposite borders of a basin, the slopes were most frequently directed towards each other; and it has been proved that sometimes there was a junction of the two slopes in the middle of the basin by a plane or curved portion which has been called the *bottom of the boat*—["*fond de batteau*,"] because, in fact, the section of the two slopes, thus united, bears resemblance to the section of a boat. This disposition, which has been too generalized for the ensemble of the formation, it having been very frequently deranged by accidents of another nature, and as regards the coal beds, when the continuity is not always established between the beds of which the slopes tend theoretically towards each other, is nevertheless, with these exceptions, a very common occurrence.

This fact indicates that coal basins have generally been compressed by lateral upheavings or pressure.

The change of inclination often involves the existence of curves of adjustment, which are only the folds [*plis*] of the beds. In the greater part of the circumscribed basins, these folds are of great radius: but, in the beds of the great northern basin of France, the folds are sometimes so sudden and decided that they change the inclination of from 10° or 15°, to that of 75° or 80° at any given point.

The section of the basin of Mons, in Belgium, is a good example of the plication or doubling back of the coal beds of the northern basin, even to such an extent as to permit the vertical shafts to pass two or three times through the same beds. Most frequently there is an enlargement of the thickness at the angle or bend ["*crochon*,"] of a ply, and the thickness of a bed of one yard is increased to one and a half or two yards. Those beds whose inclination is below twenty degrees, permit the establishment of working galleries according to the method which bears the name of flats—"*plats*," and they call uprights—"*droits*"—those which possess a high inclination. The same beds, therefore, that occur in our section of Mons, assume alternately the disposition of flats and uprights.

These folds have, at the same time, both a direction and an inclination, and form a sort of sloping gutter which is called by the Belgian and French miners "*ennoyage*."

The plications are evidently the effect of dynamic causes, which have produced these inclinations; they result from upheavings which have undulated the surface of the basin, and from lateral pressure, which has forced the groups thus undulated, to occupy a greatly contracted space.

Contractions and enlargements are frequent accidents in coal beds; they both exist, generally, in the same vein, and, in some basins, the miners are in the habit of saying, when the roof and floor widen suddenly, "the bed enlarges, we are going to lose it." A gradual and prolonged contraction, a division of the bed, whose planes of stratification become entangled in the rocks of the roof and floor; in fine, the alteration of the coal which becomes more and more mixed with argillaceous slate, constitute an impoverishment which is the ordinary precursor of a total suppression.

When the two walls of the vein, approaching each other, come to unite, and for a while to suppress the coal bed, the accident takes the name of *fault*, [*crain* or *coufflée*.]

Faults are more frequent accidents in the thick beds than in those which do not exceed a yard. By following the carbonaceous thread which almost always exists as a trace left by the coal itself, or, in default of that, by fol-

lowing the rocks of the roof and floor, of which nature furnishes indices sufficient to preserve the plane of stratification, the bed will be recovered, after an interruption of greater or less extent. In the mines of Rive-de-Gier, the lines of white slate serve as a guide, in default of carbon, by which to pass over or go by the faults. In the mines of the environs of Nantes, where the suppression is equally complete, it is necessary to consult attentively the rocks of the walls, in order to pass by, without deviation, the very considerable spaces which often separate the prolongation of the same bed.

Miners are sometimes very much embarrassed, when they have pursued the trace of a fault during a long space; for, not finding again any indication of resumption, they do not know whether the interruption should be attributed to the presence of a fault or to the definitive cessation of the coal. No rule can be laid down in this case; the observation of the structure of the whole can only furnish the data which we have already indicated above.

Faults are very common accidents. They are fractures which affect the entire character of the formation, and cause greater or less disturbances. These faults have a determinate direction, and frequently a basin is affected by a system of faults parallel with each other. At other times, there are several systems which follow different directions, but are each composed of faults, connected with each other, by a parallelism of direction.

The intensity of the faults is very variable; sometimes they scarcely interrupt the formation, and appear as fissures which have changed the level of the two ruptured parts, but not enough to constitute the total interruption of the coal, which is always easy to follow, when the offset is not greater than the thickness of the coal. The bed of Lucy, in the basin of Saône-et-Loire, frequently presents such faults.

The section of the coal bed of Monceau furnishes an example of interruptions of continuity caused by movements subsequent to the formation of the coal deposit, and of a confusion [*brouillage*] which totally interrupts the coal.

The *brouillages* are nothing but the intervals comprised between the planes of fracture; in these intervals all the beds are broken and reduced to angular blocks mingled together.

When these faults form part of those which have determined the outline of the surface of the ground, the offsets or upthrows are, in some measure, proportionate to the inequalities which it presents. Thus, there are offsets and upthrows of several hundred feet in the basins of England, of Wales, and of Rive-de-Gier, whose surface is highly disturbed.

In the basins of the Saône-et-Loire, they are rarely more than from thirty to ninety feet, and are, notwithstanding, in agreement with the undulations of the surface.

Endeavours have been made to establish, from the most detailed and available information, agreements between the arrangement of the beds of coal and the superficial accidents of the soil. Thus, in a great number of basins, the direction of their beds coincide with that of the great axis of the coal formation, and this great axis is itself directed in the same course as the existing valleys, in such a manner that the direction of the beds is confounded with that of the dividing lines of the waters and the principal valleys. In some other basins, the planes of stratification of the formation have not only the same direction, but also the same inclination as that of the surface declivities.

The basin of Bert offers a striking example of this agreement. The inclinations of its coal beds change as often as five times whilst conforming

to the inclinations of the surface, and the range of the valleys corresponds with the direction of the beds. The greater part of the basins which affect the boat form, present, at their surfaces, an analogous disposition; that is to say, the waters follow the direction of the strata, and the lateral margins of the basins are generally more elevated than the axes.*

English Coal-Fields.—Faults and interruptions prevail, more or less, as might be expected, in most coal-fields, but they possess different characters in different regions. The Newcastle coal-field is remarkable for its number of faults; from the dimensions of a few inches to a hundred fathoms. But in the southern coal basins, particularly those of the Forest of Dean and South Wales, there are frequently found remarkable irregularities, called "*horses.*" Where these horses occur, the coal disappears all at once; but yet without any fault at all. They have to be cut through, and, after a time, the coal reappears.† These horses appear to be ascribable to interruptions in the original deposition of the vegetable matter of the coal seams.

Chemical Geology, as applied to Coal.—At the tenth annual meeting of the British Association for the Advancement of Science, as reported in the Athenæum, Professor Johnston brought forward the result of his investigations on the most important of mineral productions, coal.

Although some geologists may entertain a different opinion, he assumes for granted the vegetable origin of coal. Although it may be classified in various ways, for economic or geologic convenience, as into caking or not caking, bituminous or non-bituminous, the true basis of the classification must depend on the chemical composition. Carbon, oxygen, and hydrogen, are the component parts of living vegetables, and the same elements compose coal, but in different proportions.

In the decomposition of vegetable matter, there are two agents always at work—viz. atmospheric air and water, which resolve it into carbon, oxygen, and hydrogen; forming, with one another, those combinations—carburetted hydrogen, carbonic acid, and water. Vegetable matter, consequently, in different states, showed different proportions of these elements.

The quantity of carbon in all the different varieties of coal, in Mr. Johnston's table, was taken as a constant quantity; and from lignite, downwards, we see a progressive loss of hydrogen and oxygen; until, in anthracite, the carbon is the chief component.

This is borne out by experience. In the change from lignite to fossil wood we find that carbonic acid only is parted with; and this continues, without variation, in all the kinds, down to cannel coal.

In mines of lignite and cannel coal, we find only *carbonic acid*, or *choke damp;* while in mines of coal lower in the scale, we find, in addition, *carburetted hydrogen* or *fire damp*. This also appears in the table referred to; the hydrogen diminishing in each variety as we approach anthracite.

In some mines we find a perfect confirmation of this theory. In certain Yorkshire mines, coal of different kinds, cannel coal being at the top, evidently prove that those below, having been longer subjected to chemical action, had parted with more of their hydrogen. The same occurs in mines in Lancashire.

In conclusion, Professor Johnston asserted, that bituminous matter must be of vegetable origin—in fact, chemistry proved it. Distillation of vegetable matter in a gas work, or in the laboratory of a volcano, was the same process.

In further support of this conclusion, we cite the following high authority:

* Géologie appliquée, par M. Amédée Burat, 1846.
† Professor Ansted's Geological Lectures, 1847–8.

Table of Analysis of Coal and certain allied Combustibles, by Berthier.

Composition in 100 parts.	Peat or Turf.	Lignite or Brown Coal.	Bituminous Coal—rich.	Pennsylvania Anthracite.	Graphite or Plumbago.
Carbon,	38	54	73	94	95
Hydrogen,		04	05	2.55	
Oxygen,		26	20	2.56	
Ashes,	17.4	14	02		
Volatile matter,	28				
Iron,					5

These different varieties of brown coal, peat, bituminous coal, anthracite, and graphite, correspond so exactly, that this alone would show the vegetable origin of them all; from the peat up to the graphite, if no other proofs were at hand.

VARIETIES OF COAL, WITH REFERENCE TO THEIR ADAPTATON TO THE MAKING OF IRON.

Countries and classification.		Localities of Coals.	By whom analysed.	Carbon. Per ct.	Volatile matter.	Ashes.
I. Fat, bituminous, adhesive coals; the greater part *close burning* or strong burning blazing coals.	America,	W. Penn'a, Ohio, Virg. Illinois,	Var'us persons,	52.0	44.0	4.0
	England, A,	Newcastle upon Tyne, Birtley,	Berthier,	60.5	35.5	4.0
		Northumberland, Tyne works,	"	67.5	30.0	2.5
		Staffordshire, Apdale works,	"	62.4	34.1	3.5
	do. B,	" Wednesbury,	"	67.5	30.0	2.5
		Derbyshire, Butterley, Cherry,	"	57.0	40.0	3.0
		" Codnor Park, soft coal,	"	51.5	45.5	3.0
	do. C,	Lancashire, cannel coal,	Karsten,	56.0	38.5	5.5
		Scotch, " Lismahago,	Mushet,	39.4	56.6	4.0
		Derbyshire, " Morely P'k,	"	45.0	45.0	10.0
	France, D,	Anzin,	Berthier,	70 5	25.0	3.5
		Rive de Gier,	"	66.5	31.5	2.0
		Saint Etienne,	Gruner,	74.3	24.2	1.5
II. Dry coals, not very adhesive: can be used crude in the furnace with heated air. *Open burning coals.*	Scotland, E,	Clyde, splint coal,	Mushet,	59.0	36.8	4.2
		" clod coal, richest,	"	70.0	26.5	4.5
		" near Glasgow,	Berthier,	64.4	31.0	4.6
		Calder, near "	"	51.0	45.0	4.0
		Monkland, "	"	56.2	42.4	1.4
III. Less adhesive or caking.	U. States, F,	Pennsylvania, Philipsburg,	Johnson,	68.0	22.0	10.0
		" Karthaus,	"	68.1	26.8	5.1
		Virginia, Richmond,	Clemson,	64.2	26.0	9.8
		Illinois, Ottawa,	Fraser,	62.6	35.5	1.9
IV. Steam coals, very dry coals, with excess of carbon. *Open burning.* Intermediate class, semi-bituminous.	S. Wales,	Dowlais, iron works,	"	79.5	17.5	3.0
		Merthyr Tydvil, "	"	78.4	18.8	2.8
		Pen-y-Daran, "	Mushet,	86.0	12.0	2.0
		Aberdare, "	Unknown,	87.0	11.5	1.5
		Rhymney & Tredegar, works,	Mushet,	81.0	15.0	4.0
		Steam c'l, Pembrey & Llanelly,	" [mean]	80.0	17 0	3.0
	Belgium,	Mons, Dour,	Berthier,	85.0	12.7	2.3
	France,	Auvergne, Saint Etienne,	Gruner,	74.8	21.7	3.5
	America, U. S.	Dauphin Co. Pa. Rattling Run,	Lea,	76.1	16.9	7.0
		Maryland, Savage River,	Jackson,	77.0	16 0	7.0
		Pennsylvania, Blossburg,	Clemson,	75.4	16.4	8.2
		" Broad-top,	"	70.1	16.7	13.2
V. Anthracite,	S. Wales,	South Wales, Neath Valley,	Mushet,	91.0	8 0	1.0
		" Ystal-y-ferra,	"	92.5	6.0	1.5
		" Cwm Neath,	"	95.7	2.8	1.5
	U. States,	Pennsylvania, Pottsville,	Rogers,	94.1	1.4	4.5
		" Black Sp. Gap,	Lea,	88.6	7.1	4.3
		" Mauch Chunk,	Rogers,	88.5	7 5	4.0
		" Sugar-loaf,	Johnson,	90.7	7.0	2 3
		Rhode Island, Portsmouth,	Jackson,	85.0	10.0	5.0
		Massachusetts, Mansfield,	"	92.0	6.0	2.0
	Russia,	Territory of the Don Cossacks,	Voskressensky,	94.2		

A, Coals which cannot be employed in iron works, in the crude state.
B, Coals which cement less in the fire, and which it is practicable to use raw in furnaces worked with heated air.
C, Chiefly for illuminating gas.

In the belief that every species of information which makes the adaptation of the various mineral combustibles to the manufacture of iron better understood, must be useful and in strict conformity with the plan of the present work, we have arranged the foregoing practical details. Great changes have taken place, within a few years, in the management of fuel, and in the degree of estimation in which each species is held by operative and scientific men. It is proper to know the conclusions to which those persons have arrived. We cannot here give all those results in detail; and, moreover, this is not a treatise on iron making. But we have sought to concentrate certain material facts on the nature and capabilities of the principal varieties. It will then be easy to compare them with others of corresponding character. We have therefore given, in the preceding page, a comparative table and characteristic analysis of the principal descriptions of coal employed in the iron works of Europe and the United States.

CLASSIFICATION OF MINERAL COALS.

In the foregoing table of analysis of coals and anthracites we have so arranged them as to exhibit their varieties or gradations, and their distinguishing properties, in different countries. Hence, the European coals can readily be compared with those of America, and the adaptations of either may be assigned with some degree of confidence. We proceed to note these characteristic differences and agreements more in detail.

I. *Fat Bituminous, blazing, coking.*—In the first class, series A, of the table, by way of illustration, the English coals of the north, and some of the coals of Silesia, of Hesse, of France, and of America, in the Ohio Valley, are chiefly fat and very adhesive or caking; swelling much in the fire. The hot air blast is successfully applied with these in the high furnaces. But, as their tendency to cement together in a solid mass, when in the fire, is such as to prevent a free draft or passage of the air through the furnace, it has been found indispensable to submit the coals to a preliminary process, and to reduce them to coke. Thus, the difficulty is wholly removed; and a light, cellular, and purely carbonaceous substance, easily ignited, is substituted for the unmanageable coal in its crude state. The average quantity of carbon which the English coals possess, is stated to be sixty-five per cent.

Series B, more southward, in Staffordshire and Derbyshire: these coals, although containing as much, and even more bitumen, do not melt together like those of Northumberland. They scarcely change their form even in the state of coke. The varieties, having this property, admit of their being used in the *raw state*, but require the introduction of hot air into the furnaces. Some of the American coals west of the Alleghany mountain have also these characters.

In regard to the manufacture of illuminating *gas*, the type of perfection, in the series C, is the Scotch cannel; then comes after it the Lancashire cannel, and, in the third order, the Yorkshire and Derbyshire cannel. With this class we would place the cannel coals of Kentucky, Indiana, Illinois and Missouri. This series can be assimilated, in many respects, to the coal of the basin of Mons in Belgium. The splint coal of Scotland is only a coarse variety of cannel, as are the greatest part of all the Scotch coals.

The Newcastle coals have a resemblance to those of Anzin, of Saint-

Etienne, and of Rivè-de-Gier, the analysis of which we have placed in the series D.

II. Series E.—In the second class, the Scotch coals, although containing as much bitumen as those of the north of Scotland, are of the kind denominated *dry coals*. They cement together, but without change of form, and are not so adhesive as the fat English coals. These were heretofore coked before being put into the furnaces; but recent improvements have shown that, with the application of heated air, they can be employed without being previously carbonized. Their average proportion of carbon is about sixty per cent., and of bitumen 36 per cent. Some of the Alleghany coals will probably be found to assimilate with these. Approximating to the same class, to a certain point, will be found the coals of Auvergne and of a part of the south of France.

III. Series F.—We have assigned an intermediate space for a series of coals in the American coal basins which differ little from E, except that they contain somewhat less of bitumen and more of carbon, viz. about 66 per cent. of carbon and 27 per cent. of bitumen and volatile matter, and are less adhesive and caking. The Heraclea coal, in Anatolia, appears to belong to this series, and those of the Cantal and Puy de Dôme in France. These are convertible into coke.

IV. *Intermediate Series, very dry coals,—Semi-bituminous coals,—Steam coals.*—In the fourth class, of which the Welsh coal of the southern and eastern districts is the type, and which possess only from twelve to twenty per cent. of volatile matter and bitumen, may be arranged those denominated "very dry coals, with excess of carbon." These do not cake or cement together in a mass, although each individual fragment is susceptible of conversion separately into coke, and consequently do not offer a similar obstruction to the current of air in the furnace, like those of the first class. It has, therefore, been found that they may be employed in a crude state in the cold air furnaces of South Wales. This class contains a larger proportion of carbon than the two others, being eighty-one per cent.

There exist both in France, Saxony and Belgium, coals which bear some resemblance to these. In the United States of America, particularly in Maryland, Virginia, and Pennsylvania, are some species which closely assimilate with the foregoing, usually denominated "open-burning," and sometimes "semi-bituminous," and are not surpassed by any known species for certain valuable properties.

Under this head may be arranged the culm of Kilkenny and of Glamorganshire, and the quality which prevails in some of the southern seams of the Welsh coal-field, and now universally known by the name of "steam coal," being supplied to the British marine steamers, and even to those of France and Egypt. The Welsh culm is a very light coal, of loose texture, very glossy, and composed of capillary fibres arranged in divergent rays. It burns easily, and without smoke, makes a lively fire, and is in great request in Swansea and Cornwall for the smelting of copper. Depots of steam coals are formed in the East and West Indies, and in various parts of the world, for the service of the English steamers.

There is in England another variety of coal, but not abundant, called *flint coal*, because it is almost as hard as flint, and has a shining fracture approaching to anthracite. The *flew coal* of the mines of Wedgebury in Staffordshire, belongs to this series. In Cumberland, at Alston Moor, a variety of coal is found, almost without bitumen, called *crow coal*, which approaches to the French coal of Fresnes.

V. In the fifth class are comprised the anthracites, or non-bituminous coals. We shall enter more into detail when we treat of the coal districts of Wales and the United States. Our tables of analysis exhibit the component parts of this mineral from all the principal known deposits. In Pennsylvania it contains from 85 to 92 per cent. of carbon; in South Wales from 88 to 95; in France 80 to 83: in Saxony 81, and in Russia reaches 94 per cent.

After many years of unsuccessful trial in endeavouring to adapt this valuable mineral combustible to the manufacture of iron, the difficulties, which at one time seemed insurmountable, were overcome, both in Wales and in Pennsylvania, where many furnaces, using the hot blast, are now in full activity. The domestic use of anthracite, in the United States is very extensive, and annually increasing; all the original objections to its use having vanished.

In the United States of America the investigation of coal is of so recent a date that we have scarcely had time to institute comparisons with the corresponding combustibles in Europe. Nor have we acquired more than a meagre amount of information in relation to the economic value of similar substances in other countries.

While in the new world, remarkable as it may appear, the most simple properties of mineral fuel have scarcely been known half a century; while the first anthracite found its way from Pottsville to Philadelphia in the year 1812; from the Lehigh region in 1814, and from Wilkesbarre in 1820;—while the first bituminous coal reached tide water down the Susquehanna only in 1804, the coals of England had been employed for fuel and manufactures from the beginning of the thirteenth century; those of Scotland towards the close of the same century; of France at the beginning of the fifteenth century, and in Belgium the coal mines had been in operation at least as early as the year 1198.

The amount of current information as to what has been effected, and as to what is the existing condition, in other parts of the world in relation to coal mining industry and the enormous developments of this mineral in various countries, even during our own time, forms a department in industrial statistics which greatly needs elucidation, for the details which it embraces are by no means of easy access to the inquirer, either in the new or the old world. It is the growing necessity for such information, the demand for a multitude of essential data for which we have so often to seek in vain, that has led to the preparation of the present volume, and has encouraged its author to persevere. We feel assured, moreover, that in the concentration of such a multitude of useful facts which time has developed, but which are now, in great measure, for the first time brought together, we are conferring no slight accession to the generally prevailing knowledge, on a subject which is annually acquiring importance, and becoming more intimately connected with the advancement of the human race.

It may be useful to pursue these preliminary notes on the classification of mineral combustibles somewhat further; and we, fortunately, are not without ample scientific authority for extending this section as far as our space will permit.

It has been perceived that similarity of results in analysis, is not of itself an entire and decisive guide to the ascertainment of all the properties of coal. Even as regards chemical results, apparently parallel, discrepancies are discoverable, when the investigation is carried further, which show the absence or presence of principles that materially influence operative results.

Thus, in coals containing similar quantities of carbon, those of the north of England and in Scotland, for instance, the analytical results, acquired by Dr. Thomson, prove that the relative quantities of hydrogen, carbon and azote, materially differ. Again, external properties and characters must likewise be consulted. The structure and texture of the coal, the density, the mode in which it burns in the fire, swells or decrepitates, and other phenomena must be attended to. We have seen, for example, that some of the English coals possess so strong a tendency to melt, cement, and coke, as to form a hollow fire, and cannot be used in iron works without previous coking; while other coals, even such as possess ten to twenty per cent. more of bitumen, swell but little; and although their fragments cohere in the fire, they do not change their form and bulk, even in the process of coking.

There is yet another mode which has been employed to compare, with still greater delicacy, the respective qualities and composition of these combustibles. This is by means of the relative proportions of carbon and gaseous matters, ascertained more completely than is exhibited in the usual form of analysis. For a knowledge of these results, and some others that we propose to introduce, we are indebted, in great measure, to the work of M. Pelouze on gas.*

"All the *compact coals*, even the fattest, the most coking, the most inflammable—in a word, those which the English designate by the name of "*close-burning coal*," and which yield to distillation a coke, always more or less abundant, dense, and of better quality than those of the light coals—ought to be avoided for the manufacture of gas.

But among the eligible coals, how many distinctions still remain to be made. We are often astonished to find that the lightest coal—that which leaves the least residuum after its combustion—above all, that which possesses characters entirely bituminous; which kindles rapidly, and gives out a fine and elongated flame, yields much less gas to distillation than some other variety of the light coals which possess the same apparent characteristics, or which were even far from promising as much.

We are acquainted with a great number of analyses of coal, made at various periods; but all at a time when the science of the analysis of organic bodies had made little advances. Besides, the only object of those analyses was that of stating the respective proportions of coke, or de-bituminized coal, and the incombustible residuum which the coke yielded by a complete incineration. Little attention was given to determining the component parts of the bituminous portion.

Mr. Richardson has devoted himself to researches in the laboratory of Professor Liebig, at Giesen. He has examined the English coals.

We give the results of his analyses, the more willingly that his examinations have been directed to the produce in coke, and to the elements of the bituminous portion.

British Bituminous Coals.

With the certain means that chemists possess, now-a-days, for analysing organic substances, such a work, published by a person so competent in these matters, ought to inspire confidence. Now we see that in the bituminous portion of the coals assayed by Mr. Richardson, the proportion of oxygen varies from 14.54 for 6.33 of hydrogen, to 5.50 for 5.31 of hydrogen. There is, therefore, reason to think, that in the distillation of the first variety,

* Traité de l'éclairage au Gaz, avec 24 planches, par Pelouze Pere, Paris, 1839.

in consequence of the formation of water, there would remain very little hydrogen for the production of gas for illumination; while the second variety would have yielded a much more abundant result of carbonated hydrogen gas.

Species of Combustible.	Locality.	Composition.				Composition after deducting the ashes.		
		Carbon.	Hydrogen.	Oxygen.	Ashes or Cinder.	Carbon.	Hydrogen.	Oxygen.
Splint Coal,	Wylam,	74.823	6.180	5.085	13.912	86.91	7.18	5.91
	Glasgow,	82.924	5.491	10.457	1.128	83.87	5.55	10.58
Cannel Coal,	Lancashire,	83.753	5.660	8.039	2.548	85.94	5.81	8.25
	Edinburgh,	67.597	5.405	12.432	14.566	79.13	6.33	14.54
Cherry Coal,	Newcastle,	84.846	5.048	8.430	1.676	86.29	5.14	8.57
	Glasgow,	81.204	5.452	11.923	1.421	82.38	5.53	12.09
Caking Coal,	Newcastle,	87.952	5.239	5.416	1.393	89.19	5.31	5.50
	Glasgow,	83.274	5.171	9.036	2.519	85.43	5.30	9.27

At the same time that Mr. Richardson was operating at Giesen, M. Reynault, an aspiring mining engineer, was devoting himself at Paris to similar researches, with much assiduity. We give below the principal results which he has obtained.

European Bituminous Coals.

Analysis per cent., the earthy residuum being previously abstracted. The results show the mean of three different assays for each species of coal.

Localities.		Carbon.	Hydrogen.	Oxygen.
1. Coal of Alais, basin, No. 23, mine of Rochebelle,	France,	90.55	4.92	4.53
2. Coal of Lavaysse, Dep. of the Aveyron,	"	82.12	5.27	7.48
3. Coal of Mons. 1st variety of *Flenu*,	Belgium,	86.49	5.40	8.11
4. " 2nd " "	"	87.07	5.63	7.30
5. Coal of Epinac, basin No. 11,	France,	83.22	5.23	11.55
6. Coal of Blanzy, No. 10,	"	78.26	5.35	16.39
7. Cannel Coal of Lancashire,	England,	85.81	5.85	8.34
8. Coal of Commentry, basin No. 13,	France,	82.92	5.30	11.78
9. Coal of Rive-de-Gier, " No. 20, Grande-Croix,	"	89.04	5.23	5.73
10. " " " " Rassaud,	"	89.07	4.93	6.00
11. " " " " Corbeyre,	"	90.53	5.05	4.42
12. " " " " Cimetiere,	"	85.08	5.46	9.46
13. " " " " "	"	87.45	5.77	6.78
14. " " " " Couzon,	"	84.49	5.75	9.36
15. " " " " "	"	86.30	5.27	8.43
16. Coal of Noroy, basin No. 3, Vosges,	"	78.32	5.38	16.30
17. Coal of Oberkirchen,	Westphalia,	90.40	4.88	4.72
18. Coal of St. Girons, Dep. of L'Arriege,	France,	76.05	5.69	18.26

We remark how much the proportions of oxygen in relation to hydrogen, vary, even in their most extended limits: and if we admit that the abundance of the first is injurious to the production of gas for lighting, all the uncertainty which is generally observed in the result of the manufacture is explained.

Many of the coals comprised in the preceding table are defective by an absolute want of hydrogen; but several others, even those rich in hydrogen, by the association of that with a too strong proportion of oxygen, which in the distillation of coal disengages itself with the hydrogen, both being in a nascent state, are found in conditions favorable to combination; that is to

say, to the production of water, to the detriment of the quantity of illuminating gas.

Anthracites.

Localities.		Carbon.	Hydrogen.	Oxygen.
1. Anthracite of Pennsylvania,	United States,	94.89	2.55	2.56
2. Coaly Anthracite of Rolduc, near Aix-la-Chapelle,	Belgium,	92.85	3.96	3.19
3. Anthracite of Mayenne,	France,	93.56	4.28	2.16
4. " of South Wales,	Wales,	94.05	3.38	2.57
5. " of La Mure, Dep. of Isere,	France,	94.07	1.75	4.18
6. " of Macot,	La Tarantaise,	97.23	1.25	1.52

We here perceive that the anthracites are absolutely wanting in hydrogen, independently of the consideration of oxygen. It explains then very well why this species of combustible is the least convenient substance for the manufacture of illuminating gas."*

The results, according to the English engineer, Luke Herbert, obtained from a series of experiments made upon each of the three classes of English bituminous coals, and in each case by the distillation of one ton of the coal, are as follows:

1. Cannel coal of Lancaster produced 11,600 English cubic feet of gas.
2. Coal of Newcastle, (Hartley mine,) 9,600 do.
3. Coal of Staffordshire, best quality, 6,400 do.

By experiments on a similar scale to the last, were obtained the following results:

1. Wallsend coal, - - - - 10.300 cubic feet of gas.
2. Temple Main, - - - - - 8.100 do.
3. Primrose Main, - - - - 6.200 do.
4. Pembrey, - - - - - - 4.200 do.

The gas obtained possessed an illuminating power much inferior to that from the coal of the first class; but there was much coke of good quality.

In this class the series terminates with the drier and less adhesive coals, called "open burning coals." Those of this kind are preferred by blacksmiths because they better bear the blast of the bellows.

ADAPTATION OF DIFFERENT VARIETIES OF COAL TO THE PURPOSES OF STEAM NAVIGATION.

There has been recently published a very elaborate report, of 607 pages, "to the Navy Department of the United States, on American coals applicable to steam navigation and to other purposes, by Prof. Walter R. Johnson." It includes two hundred and one tables, prepared by the author with unusual care and under peculiar advantages, and furnishes the results of a long series of experimental investigations conducted at Washington.

Our space precludes our quoting extensively from this voluminous document; but we cannot refrain from selecting the following table of the relative degree of evaporative power of different coals under similar or uniform *bulks*. We select this table, at the suggestion of the author, in preference to that which exhibits "the order of evaporative power under equal *weights*." He remarks that coal, "when sold by weight and used on shore, the weight per

* Pelouze on Gas.

cubic foot is a point of little moment. Space for stowage is easily obtained. But in steam navigation, bulk, as well as weight, demand attention; and a difference of *twenty per cent.*, which experiment shows to exist between the highest and the lowest average weight of a cubic foot of different coals, assumes a value of no little magnitude. This is obviously true, since, if other things be equal, the length of a voyage must depend on the amount of evaporative power afforded by the fuel which can be stowed in the bunkers of a steamer, always of limited capacity."

Classification of American Coals, in the order of evaporative power under equal *bulks*, to which is added the relative numerical rank of the same coals under equal *weights*, also in the order of their specific gravities, and of their marketable weight.

No.	Names and Localities.	State or County.	Quality.	Pounds of steam from 212°, produced by one cubic foot of each coal.	Relative evaporative power, for equal *bulks* of coal.	The same Coals. Evaporative power under equal *weights*.	In the order of their specific gravities.	In the order of their weight in the marketable state.
1	Atkinsons, Cumberland coal,	Maryland,	Dry bituminous c'l.,	566.2	1.000	1	29	21
2	Beaver Meadow, Slope V.,	Pennsylvania,	Ant'cite, white ash,	556.1	.982	7	3	1
3	Peach Mountain,	Schuylkill Co., Pa.,	" red ash,	545.7	.964	3	6	11
4	Forest Improvem't,	" "	" white ash,	540.8	.955	4	5	13
5	Easby's, Cumberland coal,	Maryland,	Dry bituminous c'l.,	535.6	.946	6	21	23
6	N. Y. and Maryland comp.,	Cumberland coal,	" free burning,	524.8	.927	9	9	12
7	Queen's Run coal,	Clinton co., Penn.,	Moderately bitu's,	517.0	.913	2	22	28
8	Blossburg,	Tioga co., Penn.,	"	515.9	.911	10	25	20
9	Neff's, Cumber'd cl,	Maryland,	Free burning bitu's,	512.7	.906	12	20	9
10	Easby's "coal in store,"	Cumberland, Md.,	"	511.1	.903	5	30	16
11	Beaver Meadow, No. 3,	Pennsylvania,	Ant'cite, white ash,	505.5	.893	15	1	5
12	" navy yard,	"	"	500.0	.883	18		4
13	Mixture 1-5th Cumberland and 4-5ths Beaver Meadow,		Mixed,	498.5	.860	16		6
14	Lehigh coal,	Pennsylvania,	Ant'cite, white ash,	494.0	,872	23	2	3
15	Ralston,	Lycoming cr'k., Pa.,	Moderately bitu's,	493.3	.871	24	16	2
16	Summit Portage c'l,	Cambria co., Pa.,	Bituminous,	486.9	.860	14	12	17
17	Mixture 1-5th Mid-Lothian and 4-5th Beaver Meadow,		Mixed,	481.1	.850	25		8
18	Barr's deep run,	near Richmond, Va.,	Bituminous,	478.7	.845	19	17	19
19	Lackawanna,	Pennsylvania,	Ant'cite, white ash,	477.7	.844	8	10	30
20	Karthaus,	"	Moderately bitu's,	477.4	.843	17	34	22
21	Stony creek, Perseverance seam,	Dauphin co., Pa.,	Semi-bituminous,	472.8	.835	13	8	26
22	Lykens valley,	" "	Anthracite,	459.7	.812	11	15	31
23	Pictou,	Nova Scotia,	Bituminous,	450.6	.796	33	28	15
24	Mid-Lothian, av'ge,	Richmond, Va.,	"	448.5	.792	35	31	10
25	Crouche's pits,	"	"	445.0	.785	34	7	14
26	Newcastle,	England,	Fat bitu's coal,	439.6	.776	27	38	25
27	Mid-Lothian, 900 ft. shaft,	Virginia,	Bituminous,	433.7	.766	29	13	27
28	" new shaft,	"	"	418.6	.739	26	24	32
29	Pictou, Cunards,	Nova Scotia,	"	417.9	.738	30	23	29
30	Chesterfield comp.,	Richmond, Va.,	"	410.9	.726	20	32	40
31	Mid-Lothian, scr'nd,	"	"	408.7	.722	22	35	39
32	Natural coke,	"	"	395.3	.698	31	26	37
33	Creek company,	Chesterfield co., Va.	"	391.8	.692	32	27	38
34	Pittsburg,	Pennsylvania,	Fat bitu's coal,	384.1	.678	36	39	36
35	Sydney coal,	Cape Breton,	Bituminous,	378.9	.669	37	19	35
36	Liverpool,	England,	Fat bitu's coal.	375.4	.663	38	37	33
37	Scotch,	Scotland,	Bituminous,	353.8	.625	42	4	24
38	Tippecanoe,	nr. Petersburg, Va.,	"	350.2	.618	39	18	42
39	Cannelton,	Indiana,	Cannel coal,	348.8	616	41	36	34
40	Clover Hill,	Richmond, Va.,	Bituminous,	347.4	.614	40	33	41
41	Coke of Cumberland coal,	Maryland,	Coke,	284.0	.502	21		44
42	Coke of Richm'd c'l,	Virginia,	"	282.6	.499	28		43
43	Dry pine wood,		Pine wood,	98.6	.175	43	40	45

ADAPTATION OF COAL TO STEAM POWER.

We learn, through various channels, that the Lords of the Admiralty, in England, have taken up the subject of coal, not solely as relates to its economic working and consumption, but with reference to the probable quantities absolutely workable in Great Britain, the most economic methods of combustion, and the chemical properties and combinations of coal. An inquiry was announced as in progress, in the close of 1846, in reference to the value of coals for the use of the British steam navy. It is designed not merely to ascertain, by chemical analysis, the constituents of different sorts of coal, but, by an extensive series of comparative experiments, to determine their practical applicability. With this object in view, it is announced that steam boilers and furnaces have been erected at the Engineering College at Putney, and the examination is intrusted to Sir Henry de la Beche and Dr. Lyon Playfair, and those associated with them.

The editor of the Mining Journal remarks,* "our beds of coal have been the undoubted production of ages; and, vast as they are, it appears the height of the ridiculous to assert, that they are inexhaustible. Every succeeding year brings its increasing consumption, not simply of tons, but of millions; and perhaps there is no other question in the range of political economy that deserves so much patient investigation, and no body of men so highly competent to the task as the gentlemen alluded to."

General View or Table of the relative density of different species of Coal and Anthracite, at various parts of the World.

In a previous page we took occasion, by means of the requisite tables, to exhibit the relative amounts of carbon and volatile matters which exist in the principal bituminous coals of England, Scotland, Wales, Belgium, France, and the United States of America; and hence to show their comparative adaptation to the manufacture of iron. The following table offers another method of making useful comparisons of the bituminous and non-bituminous combustibles in various parts of the world, by means of their respective specific gravities and weights per solid cubic yard, in pounds, avoirdupois.

Localities of Bituminous Coal.	Specific gravity.	Weight of 1 cubic yard, in lbs.	Localities of Anthracites and Anthracitous Coals.	Specific gravity.	Weight of 1 cubic yard, in lbs.
UNITED STATES.			UNITED STATES.		
Pennsylvania.			*Pennsylvania,—Semi-bituminous, intermediate coals, dry, blazing.*		
Pittsburg,	1.265	2134			
Mercer county,	1.275	2151			
Karthaus,	1.263	2131	Somerset co., 18 p. ct. bitu'n,	1.382	2332
Farrandsville,	1.339	2257	Blossburg, 15 to 18 p. ct. bit.,	1.400	2362
Philipsburg,	1.358	2292	Dauphin co., Rattling run,	1.391	2347
Blossburg,	1.371	2313	Lebanon co., Yellow Springs,	1.395	2351
			Broad Top Mn., Bedford co.	1.700	2868
Virginia.					
Wheeling,	1.230	2075	*Maryland.*		
Kanawha, salines,	1.250	2109	Frostburg, 12 to 20 p. ct. bit.,	1.552	2619
Richmond,	1.246	2102			

* Mining Journal, August 1st, 1846.

Localities of Coal.	Specific gravity.	Weight of 1 cubic yard, in lbs.	Localities of Anthracites, &c.	Specific gravity.	Weight of 1 cubic yard, in lbs.
UNITED STATES.			UNITED STATES.		
			Tennessee.		
States.			Cumberland Mountains,	1.450	2447
Ohio,	1.270	2140	Mean weight in the U. S.		2475
Kentucky,	1.250	2106			
Indiana,	1.260	2126	*Pennsylvania,—Anthracites.*		
Illinois,	1.273	2146	Lykens valley,	1.327	2240
Average in U. States.		2160	Lebanon co., grey vein,	1.379	2327
			Schuylkill co., Lorberry c'k,	1.472	2484
			Pottsville, Sharp Mountain,	1.412	2382
EUROPE.			" Peach "	1.446	2440
			" Salem vein,	1.574	2649
England.			Tamaqua, vein N.,	1.600	2700
Newcastle, cherry coal,	1.266	2136	Mauch Chunk,	1.550	2615
" caking,	1.270	2143	Nesquehoning,	1.558	2646
Wigan, "	1.275	2151	Wilkesbarre, best,	1.472	2484
Durham, "	1.274	2150	West Mahonoy,	1.371	2313
Lancashire, cannel,	1.199	2023	Beaver Meadow,	1.600	2700
Derbyshire, furnace coal,	1.264	2133	Girardville,	1.600	2700
Shropshire, "	1.268	2140	Hazelton,	1.550	2615
			Broad Mountain,	1.700	2869
Scotland.			Lackawanna,	1.609	2715
Glasgow, cherry coal,	1.268	2140			
" splint,	1.307	2205	*Massachusetts.*		
Wylam, "	1.302	2197	Mansfield,	1.710	2885
Edinburgh, cannel,	1.318	2224			
			Rhode Island.		
France.			Portsmouth,	1.810	3054
Puy-de-Dôme,	1.310	2212	Average in U. S.		2601
Cantal,	1.300	2193			
Auvergne,	1.320	2222	EUROPE.		
Allier,	1.330	2244	*South Wales.*		
			Swansea,	1.263	2131
Belgium.			Cyfarthfa,	1.337	2256
Hainaut,	1.270	2140	average,	1.350	2278
Liege,	1.300	2193	Ynis-cedwin,	1.354	2284
Silesia.			*Ireland*, mean,	1.445	2376
Frederich,	1.263	2131			
Gustaw grobe,	1.270	2140	*France.*		
Average in Europe.		2164	Allier,	1.380	2207
			Cantal,	1.390	2283
			Brassac,	1.430	2413
ASIA.					
			Belgium, anthrac's coal of		
Bengal, Hurdwar,	1.368	2308	Mons,	1.307	2105
" Chirra Punjee,	1.447	2441	Westphalia,	1.350	2278
Assam, Kosya hills,	1.275	2151	Prussian Saxony,	1.466	2474
Aracan, Birmese,	1.308	2207	Saxony,	1.300	2193
Average in Asia.		2277	Average of Europe.		2281

From the foregoing table several useful facts are made apparent. The first is, the greater weight of the American anthracites than those of Europe; second, that the bituminous coals very closely coincide in both quarters of the globe.

	Average weight of a cubic yard.		
	Bituminous coals.	Anthracites.	Intermediate species.
Mean weight of the American,	2560 lbs.	2601 lbs.	2475 lbs.
" " European,	2164 "	2281 "	
" " Asiatic,	2277 "		

We have neither added the weight of the intermediate species of coal to the bituminous column nor to the anthracites; because, in either case, it would have unduly affected the true character of the averages. Third, as

regards the table of American anthracites—and it may be correct also to include that of the bituminous coals—it will be seen, with the assistance of a map, that their specific gravity increases as we advance from west to east: confirming also the fact, noted elsewhere, that the weight of the combustible decreases in proportion to the amount of bitumen with which it may be charged.

The Anthracites of Pennsylvania, commonly distinguished as White Ash, or Red Ash Coals, and selected according to their respective qualities.—Whilst treating on the comparative value of the varieties of Pennsylvania anthracite, as applied to iron making, we have said but little in relation to their relative values for domestic use. It seems established that, for closed furnaces, for warming houses, the white ash variety, being the most compact, dense, and slow burning, is more durable, and consequently, more preferable than the softer red ash coal. In open grates, for warming apartments, the latter is decidedly preferred. We have observed a recent statement of the result of an experiment, in relation to this point, which, as regards the warming of apartments, seems tolerably decisive.

A very important and interesting experiment was recently made for the purpose of testing the comparative value of the red and white ash coals for *domestic* purposes. Two rooms of nearly the same size, and having the same temperature, were selected to ascertain how many pounds of each kind would be required to heat them to a temperature of 65 degrees, during a period of 15 hours, when the temperature out of doors at 9 A. M. was at ten degrees below the freezing point. Two days were occupied in the trial, so that the red and white ash coals might be used in *alternate* rooms. Fires were made at 9 A. M. and continued until 12 P. M. Two thermometers (one in each room) were suspended at the greatest distance from the grates, and the temperature was carefully registered every hour. The result was as follows:—

Thirty-one pounds each day of the Schuylkill *red* ash coal gave a mean temperature of 64 degrees; and *thirty-seven* pounds each day of the *white* ash, taken from a vein of high repute in the Lehigh region, gave a mean temperature of 63 degrees. Making, 2000 pounds of the red ash to be equal to 2387 pounds of the white; or, red ash coal at $5.50 per ton, to be equal to white ash at $4.61. This settles the question on the score of ECONOMY.

DEPTHS OF COAL MINES.

The following statement has been prepared from a much more extensive series, in order to exhibit the minimum, the maximum, and the average depths beneath the surface at which beds of coal are at this time productively worked, in the principal mining regions of the world.

No. of Coal-Fields.	Coal-Fields.	Depths of Coal Mines.		
		Minimum feet.	Average feet.	Maximum feet.
	Great Britain.			
X.	Ashby de la Zouch, depth reached in the works,	"	"	1167
XI.	South Staffordshire, Christchurch,	120	498	870
XII.	Coalbrook Dale,			729
XIV.	North Staffordshire, or Pottery,	100	450	725
XVIII.	Lancashire, or Manchester coal-field, Pendleton,		750	1521
	Shaft at Sankey Brook, near St. Helens,			1377
	Victoria pit, Dukinfield, east of Man'ter,			1000

No. of Coal-Fields.	Coal-Fields.	Depths of Coal Mines. Minimum feet.	Average feet.	Maximum feet.
	Great Britain.			
XX.	Yorkshire, near Wakefield,			870
XX.	Derbyshire, near Chesterfield,		300	500
	The Swan Banks colliery, near Halifax,			812
XXIII.	Whitehaven,		600	990
XXV.	Newcastle, Tyne district,	126	510	1020
XXV.	" Wear district, Monkwearmouth,	180	450	1794
XXV.	" Do. Murton colliery,			1488
XXV.	" Tees district,	180	233	480
XXVI.	Berwick upon Tweed.			360
XXIX.	Victoria colliery, Nitshill, Glasgow, Scotland, deepest mine,			1038
XXXIX.	North Wales, or Flintshire,			450
XL.	South Wales, worked by adit levels, chiefly,			480
	Duffryn colliery, near Aberdare, shafts 94 yds,			282
	Ireland.			
XLV.	Kilkenny, anthracite district,	66	102	180
LI.	Limerick, culm beds,	70		240
	France.			
I.	Valenciennes, coal pits, upwards of			1500
	Maximum of the collieries of France, 503 metres,			1635
II.	Basin of Hardinghen,			221
LVIII.	Alais, in Gard,			235
XVIII.	Decize, in Nievre,			845
	Belgium.			
I.	Mons district, Hainault province,		810	1140
II.	Charleroy, " "		482	
III.	Liege province, L'Esperance mine, at Liege, 450 metres,			1476
	North America, United States.			
	In this country, the short period in which the coal beds have been worked, has not occasioned the sinking of vertical shafts to any considerable depth.			
	The deepest anthracite mines of *Pennsylvania* are commonly worked by sloping shafts, which follow the inclination of the seams.			
	In numerous positions the coal can be mined by adit level as in Wales, several hundred feet below the mountain summits.			
V.	Virginia, Richmond coal-field, the deepest mines in America.			
	Midlothian shaft,			775
	Heth's pits,			700
	Wills,			700
	Anderson's shaft,			450
	Gowrie pits,			460
	British America.			
	Nova Scotia, Pictou mines,	60		240

SYSTEMS FOR WORKING COAL MINES.

We have devoted but small space to this subject; not that we are insensible of its extreme importance, but because it was somewhat out of the scope we had assigned to the present volume, and also because this knowledge may be separately obtained through the medium of numerous publications by experienced persons; conveying that precise description of information, for the benefit of those who are practically engaged in this service, or are interested in this description of property. It would be invidious, perhaps, to make mention of some of these, without including all.

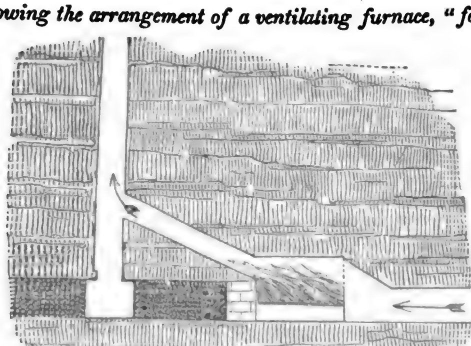
The Parliamentary Reports embody a great amount of practical information on the methods employed in excavating coal mines. The pages of the Mining Journal, during many years, have been rich in valuable details of the same kind: and among the most recent of its articles is one from Mr. Dunn, "on the various systems practised in the conducting of coal mines, and of the methods employed in counteracting the effects of inflammable air."* This article has elicited criticism and additional facts from others, equally paractical, through the same useful channel.

This subject is also treated on at some length, in Dr. Ure's Dictionary of Mines, &c. The method of working the thick coal veins of France will be found in the present volume, at page 332, showing the practice adopted in the mine of Blanzy. The mode of working the main or ten yard coal at Dudley, in England, is also described at page 286 and illustrated by fig. 20.

At page 420, we have supplied a brief account of an extremely interesting coal mine, that of Anzin, in the coal basin of Valenciennes. The coal measures are here, as at Mons in Belgium, covered by an enormous thickness of horizontal cretaceous and tertiary strata, through which it is necessary to penetrate. These overlying beds are called by the French miners "*morts-terrains*," or dead lands, and being highly charged with springs of water, require great skill and enormous expense in sinking the shafts through, until they reach the inclined coal seams, at the depth of from two hundred and twenty to eight hundred feet beneath the surface.

In order to show more distinctly the position and arrangement for the ventilating fires at the bottom of the shafts, we introduce the following enlarged figure of those employed in the mines of Anzin.

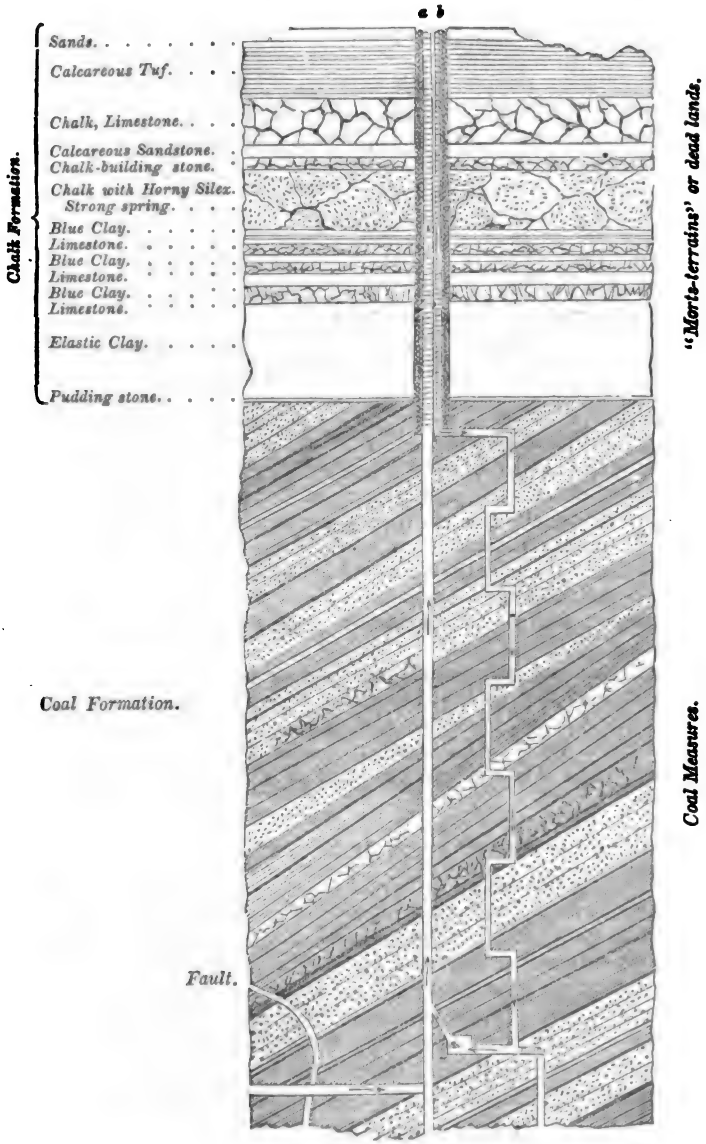
Diagram showing the arrangement of a ventilating furnace, "foyer d'aerage."



* Mining Journal, March 21 and 28, 1846. The reader will derive much interesting information, respecting coal mining operations, from the lectures of Professor Anstead, as reported in the London Mining Journal, 1847–8.

The annexed figure affords a remarkably instructive view of these circumstances, both in a mining and geological sense; showing the *revêtement* or impervious lining of the shaft, through the "dead formations;" the mode of ascent and descent provided for the miners, and the position of the ventilating fire, near the bottom of the vertical shaft.

Shaft of the Coal Mine of Anzin in France.



It is observed by M. Burat, that, as a general fact, applicable to all the methods of *exploitation*, it is necessary to be watchful that the pillars be not suffered to remain isolated, and for a long time exposed to the action of the air, before pulling them down. Coal alters in the mines almost as much as at the surface; the pyrites, contained therein, decompose, and the hydroxide of iron, which is the result, gives to the coal a rusty stain which depreciates its value. Finally, the schists disintegrate, effloresce, and the selection of the coal becomes much more difficult. It is necessary, therefore, to proportion the excavation, by preparatory works, to the extraction which may be required during the year.

Coal is, without contradiction, among the useful minerals, the one whose exploitation presents the greatest difficulties. In fact, it requires to be extracted in very large masses; its primitive value, scarcely more considerable than the stones of the mines, is, nevertheless, sufficiently important that we should not abandon the smallest possible amount of it. Left in the old workings, it is lost forever; besides, the interior sources of water and of deleterious gases incroach sometimes upon the immense subterranean surfaces that are exposed. It needs all the resources of science and industry to render possible the working of certain basins, which would have remained in abandonment without the modern means of safety and ventilation and the progress of the steam engine.

Obstructions generally develope themselves in connection with the surfaces placed under investigation. The engineer can then unfold, progressively, his means of action in such a manner as to remain always master of the exploitation. But it is the sudden accidents which defy all human prudence, which endanger the safety of the miners, and which, in a few hours, destroy the fruits of long labour and of powerful capital. The most terrible of these accidents arise from the collection of water and of gas, which in nearly all of these basins, are found accumulated in ancient workings, of which tradition has scarcely preserved the remembrance. When a cutting approaches the vicinity of one of these accumulations, a blow of the pick or a blast of the mine suffices to put the works in communication with the danger; and when it manifests itself, there is neither time to fly nor to resist it.

To avoid these sad rencounters, the miners are preceded in the drifts where danger is to be feared, by horizontal borings, *sondages*, some of them straight, others divergent. These soundings, to furnish sufficient security, ought to be about thirty feet around; if one of them reach a chasm, all the work of excavation ought to cease as soon as it is practicable to ascertain its nature.*

VENTILATION OF COAL MINES.

On the causes which vitiate the air in mines.—"The means of maintaining in the mines an atmosphere constantly respirable, and of preserving the workmen from the accidents which result from deleterious gases, constitutes one of the capital parts of the art of working, *exploiter*.

The causes which most frequently vitiate the air, are these: the respiration of the workmen; the combustion of the lamps; the explosions of powder; the spontaneous decomposition of certain mineral substances, such as the sulphurets which change into sulphates; the coal which heats and burns spontaneously; the corruption of the wood; the striking of the tools against

* Burat Géologie appliquée, p. 416.

rocks which contain ores of arsenic or mercury; in addition to which is the natural disengagement of deleterious gases which penetrate the rocks, or are accumulated in the crevices and natural cavities, and sometimes in old workings.

The gas thus produced or disengaged disposes itself in the drifts or galleries according to the order of density, as follows:

	Specific gravity.
Carbonated hydrogen, fire-damp, or inflammable gas,	0.558
Azote or nitrogen gas,	0.976
Atmospheric air,	1.000
Sulphuretted hydrogen,	1.191
Carbonic acid, or *choke-damp*,	1.524
Arsenical and mercurial vapours.	

The general precautions employed to get rid of these gases as soon as they are formed, in creating currents sufficiently active to effect their diffusion with the atmospheric air, and to draw the mixture out of the works before it is prejudicial, constitute the art of ventilation—*aérage.* But these general means do not always suffice, and it is necessary to add special means to avoid, or at least to restrain the sudden disengagements, until the common methods shall have restored the equilibrium. It is necessary, then, to be able to recognize the presence of each of these gases, in order to destroy them in time, and even, if possible, to diminish the causes of their production.

When the working of a mine, pit or gallery is commenced, if no particular phenomenon facilitate the renewal of air, the respiration alone of the workmen and the combustion of their lamps, are not slow to modify it sensibly. In fact, a workman respires an average of 800 litres = 210 gallons of air per hour, from which he absorbs, in part, oxygen, and substitutes for this oxygen, in the same space of time, 24 to 25 litres, = 6½ gallons of carbonic acid; his lamp, operating nearly with the same intensity as his respiration produces as much carbonic acid, and augments besides the proportion of unconnected azote.

The *carbonic acid*, or choke-damp, which is thus the most immediate and most general product of the workings in the mine, is recognized by its weight; it always occupies the lowest parts of the excavations; its intermixture with air manifests itself by the difficulty of combustion in the lamps, whose flame diminishes in brilliancy in proportion as the acid increases, and ends by extinction, when the mixture attains to one-tenth.

Upon the miners, the carbonic acid manifests itself by an oppression which overwhelms them; nevertheless, temperament and habit will greatly vary the proportions of the mixture which some men are able to breathe. Certain miners can yet work when the lights have ceased to burn; there are even some whose acquired habit is such that they pass through, we are assured, galleries where there is more than twenty per cent. of carbonic acid. Nevertheless, we should watch, on pain of the greatest dangers, that the lamps can everywhere burn with facility, and that the proportions never exceed five per cent.; for this gas, which the French miners commonly cal *mofette*, has the greatest tendency to isolate after generation, and will then cause an instantaneous asphyxia.

A single example will demonstrate this energetic action. The workmen of the Creuzot mine descended one morning, the one following the other, in rotation, into a shaft below, in which carbonic acid had accumulated during the night. Arrived at the level of the "*bain*," at a few yards from

the bottom of the pit, the first fell, struck with asphyxia, without having time to utter a cry; the second followed immediately; the third saw his comrades prostrated on the ground, almost within reach of his arm; he stooped to seize them, and fell himself; another quickly shared the same fate, in his desire to save the others, and the catastrophe would not have been arrested had not the fifth been an experienced master miner, who obliged those who followed him to reascend.

These accidents are often to be dreaded in coal mines, where spontaneous disengagements are capable of producing in a little time large quantities of carbonic acid. In this case, it is necessary to have within reach ammonia, caustic potash, or lime, of which a solution must rapidly be made, to be thrown into the invaded workings, either by letting it fall from a watering pot, if it be in a shaft, or projected from a pump, if it is in a slope or a gallery. It is also necessary to fight incessantly against the production of the carbonic acid, and to prevent its accumulation by leaving no wood in a state of decomposition, and proscribing all combustion beyond that of the lamps necessary for lighting. Finally, it is essential to prevent the spontaneous heating and firing which is so frequent in coal mines. When a fire is ascertained, it should immediately be circumscribed by impermeable walls, called *corrois;* walls constructed of rubbish with a mortar of clay.

The gases which result from the subterraneous decomposition of the coal, have, besides carbonic acid, carbonic oxide, azote, sulphurous acid, and the carburets of hydrogen, which have a special odour. Before the coal takes fire, the interior air is already heavy and heated by the gaseous disengagements which are the precursors of ignition. As quickly as these symptoms are remarked, the coals already mined should be raised, and we should isolate from the surrounding air the region or the crevices which enclose the fire; employing at this work the labourers whose organization is known to be the best adapted to support the deleterious influence of these gases.

Azote, or nitrogen gas, is much less to be dreaded than the carbonic acid; because its action upon the animal economy is less energetic; besides, its production can only take place by the absorption of oxygen from the air, and it does not naturally exist in the fissures or cavities of the rocks. It has, then, no spontaneous disengagement; but if we penetrate into the works which have been a long time abandoned, and where there has been combustion, the azote will occupy, in consequence of its lightness, the higher parts of the excavations, while the carbonic acid will occupy the lower parts; the respirable air forming the intermediate zone. Azote is found isolated in certain mines, where there exist pyrites in a state of decomposition; the sulphurets changing into sulphates, absorb the oxygen and isolate the azote; the sulphuret of iron is, in this respect, the most active agent.

Azote manifests itself by the red colour of the flame of the lamps, which ends by extinction; it renders respiration difficult, produces a heaviness of the head, and a hissing or singing in the ears, which seems to indicate a mode of action different from that of carbonic acid.

The ordinary lamp of the miner is extinguished when the air contains no more than 15 per cent. of oxygen: [the atmospheric air is composed of 21 per cent. of oxygen and 79 per cent. of azote,] it is also at this proportion of 85 per cent. of azote that asphyxia or suffocation is caused.

Proto-carbonated hydrogen, or inflammable air, designated by the French and Belgian miners under the name of *grisou*, is of all the gases the most dangerous; that which occasions the greatest number of accidents, not by asphyxia, which it can nevertheless produce when it is not mixed with at

least twice its volume of air, but for its property of igniting when in contact with lighted flames, and of exploding when it is mixed, in certain proportions, with atmospheric air.

This gas is frequent in nature, and often designated under the denomination of *marsh* gas, because it disengages from the stagnant waters which retain vegetable matters in decomposition. Some muddy volcanoes called salses, emit it in large quantities; it also penetrates certain rocks, such as the coal series and the saliferous strata, where it is accumulated and condensed in caverns and natural vacancies; so that by soundings or borings its true sources can often be determined. There even exist natural or artificial sources, which can be lighted and which have persistance enough to be brought into useful service.

The *grisou* is more abundant in the fat and friable coals, than in the dry and meagre coals; it particularly disengages itself in the crushed places, *éboulements*, in the recent stalls whose surfaces are laid bare, and that so vigorously as often to decrepitate small scales of coal and produce a slight rustling noise. The fissures or fractures of the coal, and even the clefts or the roof or the floor, give sometimes outlets to *soufflards* or jets of gas.

The action of this gas upon the flame of the lamps is the most certain guide in ascertaining its presence and proportion. The flame dilates, elongates, and takes a bluish tint, which can readily be distinguished by placing the hand between the eye and the flame, so that only the top of it can be seen. As soon as the proportion is equal to a twelfth part of the ambient air, the mixture is explosive, and if a lamp be carried, it will produce a detonation proportionate to the volume of the mixture. When, therefore, a miner perceives at the top of the flame of his lamp the bluish nimbus which decides the presence of the fire-damp, he ought to retire, either holding his light very low or even to extinguish it.

The experiments conducted by Sir H. Davy show that the most violent explosions take place when a volume of proto-carbonated hydrogen gas is mixed with seven or eight volumes of atmospheric air.

The chemical effects of an explosion are, the direct production of the vapours of water and carbonic acid and the separation of azote. The physical effects are, a violent dilatation of gas and of the surrounding air, followed by a reaction through contraction. The workmen who are exposed to this explosive atmosphere are burned, and the fire is even capable of communicating to the wood work or to the coal; the wind produced by the expansion is so great that, even at considerable distances from the site of explosion, the labourers are thrown down, or projected against the sides of the excavations; the walls, the timbering, are shaken and broken; and crushing, or falling down, is produced. These destructive effects can be propagated even at the mouths of the pits, from which are projected fragments of wood and rocks accompanied by a thick tempest of coal in the form of dust.

The evil rests not there; considerable quantities of carbonic acid and azote, produced by the combustion of the gas, become stationary in the works, and cause those who have escaped the immediate action of the explosion to perish by suffocation. The ventilating currents, suddenly arrested by this perturbation, are now much more difficult to re-establish, because the doors which served to regulate them are partly destroyed; the fires are extinguished, and often, even the machines fixed at the mouths of the shafts, to regulate the currents, are damaged and displaced, to such an extent that it becomes impossible to convey any help to the bottom of the works.

Some examples will give a just conception of the intensity of these explosions and of their effects.

In a gallery of a coal mine of Saarbruck, in Rhenish Prussia, the explosive air took fire on the arrival of a miner carrying a common lamp. Seven dykes or walls of bricks built in the lateral works and at twenty feet from the gallery, forming with them sharp angles, in such a manner that they could not be struck by the dilatation of the air in the direction of the explosion, but only by contraction, were nevertheless thrown down. We infer from the description that these walls fell inwards; that is, towards the point of explosion. At nine hundred feet from the explosion timber of eight inches diameter were broken; a door for ventilation was torn up, and violent effects of the same nature were manifested even at near 2000 feet distance.

In a mine of Schaumburg, the fire-damp, which filled a gallery and a shaft of 1000 cubic yards in capacity, took fire in 1839. Stones which weighed more than a ton, serving as the foundation of a hydraulic machine of the weight of twelve tons, were displaced, notwithstanding the strong wooden props which consolidated them against the direction of the explosion and which were themselves broken. In another mine of the same principality, the coal was set on fire, and this coal was coked, by that cause, even to the depth of more than a yard.

The explosion, *coup de feu*, of the mine of Esperance, which occurred at Liege, in June, 1838, does not seem to have produced such fatal effects as analogous phenomena have elsewhere done. The fire being propagated without explosion, to the right and left of a working, by the effect of a blast in the mine, produced an explosion in a distant working. Sixty-nine miners were killed. In the place of explosion they were burned and broken; in that where the fire had first taken place all the corpses were arranged with their heads directed towards the very point where the combustion originated; these unfortunate people having evidently sought to protect themselves thus against the gas which burned behind them.* In the other workings, the miners had only perished by asphyxia.

The relation of these accidents suffices to indicate the general precautions which should be taken. Thus, it is essential to place the lamps only near the lowest parts of the excavations; to avoid all methods of working which ascend without outlets; to work, if possible, by descending, rather than by ascending, and to redouble the usual precautions on entering into excavations after an interruption of the work. A great number of accidents have taken place, for example, on Monday mornings, when the miners descend after having quitted the mine on Sunday.

M. Bischof reports that having visited a gallery which had been abandoned for several days, he found the gases liquated to such an extent that they were inflammable in every part of the area; detonating in the middle portion, while the almost pure atmospheric air filled the lower part.

It is very dangerous to allow these liquations to be produced; it is necessary that the current of air be sufficiently active to produce immediately the diffusion of the gas in the air and its withdrawal out of the mine before the mixture has become explosive. But, notwithstanding the precautions of ventilation—*aérage*—many mines would be completely unworkable if there had not been found the special means of guarding them from the fire damp—

* Is it not more probable that these bodies were instantaneously thrown into this position, by the great reaction, the collapsing of the air towards the focus or vacuum caused by the explosion?—T.

grisou. The coal beds, most dangerous, are those which are the most valuable for their good qualities; science and industry have therefore been called on to seek the means of combatting the effects of the grisou, and we proceed to expose those which have been successively employed.

MEANS TO DESTROY OR CHECK THE FIRE-DAMP OR GRISOU IN SUBTERRANEAN WORKS.

The first idea which presented itself to the explorers was to disembarrass themselves of the gas by allowing the liquation to establish itself and by setting it on fire, so as to burn it, in the absence of the miners. For this purpose, a workman, clothed in vestments of moistened leather, his visage protected by a mask with spectacles of glass, advanced, crawling on his belly, in the galleries where the fire damp was known to exist, and holding forward a long pole, at the end of which was a lighted torch; he sounded thus the irregularities of the roof, the front of the excavations, and set fire to the grisous. This method, which has been employed, within twenty years, in the basin of the Loire, and even occasionally at the present day, in some of the English fiery collieries, has numerous inconveniences. The workmen, whom they called *pénitents*, were exposed to dangers to such an extent, that a great number perished. When the gas, instead of being simply inflammable, was detonating, the solidity of the mine was constantly compromised by the explosions; the fire attacked the coal and the timbers; the gases, which resulted from the combustion, became stationary in the works, and menaced the workmen with asphyxia; at length it became necessary, in certain mines, to repeat, even three or four times a day, this perilous operation, and yet it in no respect obviated the rapid disengagements which caused these numerous accidents. This method was equally in use in the English collieries; only the penitent or *fireman*, instead of carrying the fire himself, caused it to be moved by means of a slider placed over a line of poles connected together, and directed by a system of pullies and cords. The danger was thus diminished for the fireman, who retired into a niche formed in a neighbouring gallery; but in the mean while many were still overtaken, and, besides, all the other inconveniences remained.

The method called the *eternal lamps* was evidently better. It consisted in placing towards the top of the excavation, and in all the points where the fire-damp collected, lamps constantly lighted, which burned the grisou as fast as it was produced; the danger was diminished in a considerable degree, because there could not be formed such large accumulations of inflammable or detonating gas. This mode of proceeding was, however, renounced in a great number of mines, on account of the production of carbonic acid and of azote; a production the more sensitive, since, to facilitate the liquation of the gases, the air ought not to be very strongly agitated.

At length it was devised to profit by the property possessed by platina in sponge to facilitate the combustion of the hydrogen with which it brought in contact, and pellets, composed of one part of platina and two parts of clay, were made, and were placed near the points at which the grisou or fire-damp concentrated. But all these efforts, based upon the incited combustion of the inflammable gas, proved to be only dangerous and incomplete palliatives, which substituted for a great peril a series of other dangers, less imminent, doubtless, but equally distressing.

From that time all the well disposed continued to search for processes based upon another principle. Two only could conduct to a good result:

1. The withdrawal of the gases out of the mine; 2. a mode of lighting different from that which was in use, and which would suffice for the purposes of the miner without compromising his safety.

The principle of withdrawing—*entrainement*—of the gases by a rapid ventilation is, without contradiction, that which was the most natural to conceive; because it was already applied to all the other deleterious gases. Dr. Véhrle proposed at first to effect the decanting of the gases by making the excavations (stalls?) communicate by ascending passages with a gallery embracing all the works, and uniting with an ascending shaft. But this project, otherwise impracticable, offered a remedy for only a part of these accidents; the execution alone of the necessary works could not have been made without the greatest danger, if these works had been undertaken in the coal; while, in the rocks of the roof, the expenses would have rendered them impracticable. But a good ventilation alone could not suffice to place the miners in security; it was an excellent auxiliary means, but it always left unsolved this important problem: *the prevention of the inflammation of the gases which disengage themselves from the surfaces of the stalls.*

The lighting alone could conduct to the solution of this problem, and numerous attempts had been made, under this head, when Davy discovered the safety-lamp. Before him, they had operated with a small number of lights, placed in the lowest positions, and at a distance from the stalls; the workmen kept these lamps in view, and when the blue nimbus, the indication of hydrogen, began to show itself, they extinguished them or withdrew, covering them with their hats. They made use of, also, in the most infected mines, various phosphorescent matters, and particularly a mixture of flour and lime formed from oyster shells, called Canton phosphorous, although the uncertain and ephemeral light which these materials produced, was but a very feeble resource. At length it was observed that the proto-carbonated hydrogen was somewhat difficult of ignition, and that the red heat was insufficient to accomplish it; thus it was practicable to carry a red coal, or a red hot iron into the fire-damp without inflaming it, the white heat alone having the necessary temperature. They profited by this discovery by lighting the stalls by means of a wheel of steel, which was made to turn against a fragment of flint: a workman was detailed to this service, and the sparks, which were thus produced in a continuous manner, sufficed to light the miners. It happened, occasionally, that these sparks set fire to the grisou; but this discovery, imperfect as it was, was not the less a real benefit.

Such was the state of the question, when Davy commenced the series of experiments which conducted him to the object in view. Many mines had been abandoned notwithstanding the palliatives in use, and a number of those which were maintained in activity, only produced coal at the price of the lives of a great number of men. Davy discovered that the gas, contained in a vase, which only communicated with the exterior by long and straight tubes, could not be set on fire; that the flame was difficult of transmission in proportion as the tubes were reduced, and that, consequently, the more their diameters were reduced, the more their lengths might be shortened. He thus arrived at the proof that a plate of thin metal, pierced with holes of about one hundred in an inch, did not communicate fire to the exterior gas, although the interior was charged with lighted gas; the cooling produced by the gas in this small passage sufficed to reduce the temperature of the white heat of the interior down to the red heat of the exterior, and the inflammation could not be communicated. Such was the series of ideas

which conducted Davy to surround the flame of the lamps with an envelope of metallic gauze, and thus to construct the *safety-lamp*.*

LOCAL VENTILATION.

In the sinking of a shaft the work would soon be stopped by the want of air, were it not for the plan of dividing its total section into two unequal parts, by means of a partition of planks, the joints of which are hermetically closed with moss, &c. The smallest compartment is reserved for the ladders; and a current of air is established between these two compartments in the manner of an excavation having two orifices. This movement is sometimes facilitated by carrying up the level of the orifice of the small compartment, by means of planks, built up as a chimney.

The excavation of a long gallery or tunnel would become impossible, through the want of air, if a spontaneous ventilation were not produced by similar means. Thus, there are directed from the surface of the ground, towards the gallery, troughs which are arranged similarly to the works which have two orifices of different levels and unequal sections. At other times they establish upon the gangways a floor for carriages [*roulage*]; reserving the lower part of the gallery beneath for draining and for a current of air, which enters by the lower part and returns by the principal or upper section.

If this precaution do not suffice, the current may be rendered more active by means of a small shaft disposed in such a way as to accelerate the circulation during all the working time. For this purpose, two doors are placed at the entrance of the gallery, so that one of the two shall always remain closed during the work, and the air is forced to leave by the shafts. This disposition is equivalent to the case of an excavation having two orifices of different levels.

We have translated freely from the excellent work of M. Burat, already frequently quoted, most of the matter which is comprised in the preceding pages in relation to the deleterious gases which are constantly generated in coal mines, and on the means resorted to for ventilating them. Our work would be incomplete, without adverting to a subject so immediately connected with the mining of coal, and with the safety of the operators, whose lives are hourly perilled, who are exposed to accidents inseparable from its extraction, and peculiarly attendant on this branch of mining economy.

VENTILATION OF FIERY COLLIERIES.

There have been numerous suggestions on the ventilation of those coal mines which are subject to explosions; among others we may mention the published views of Mr. Dunn of Newcastle. We hope to be pardoned here for remarking that it is disadvantageous to an important practical science, and especially embarrassing to inquirers into these subjects, that the valuable information conveyed by the most capable English authorities, is so compounded of absolute technicalities, for the most part also entirely local and unscientific, as to be almost untranslateable. This is, perhaps, the main cause why the English mining processes, from Cornwall to Scotland, varying in their progress through every district, continue to be so little comprehended elsewhere.

Mr. Dunn, at page 341 of Volume X., of the London Mining Journal, furnishes a sketch of the general principles of ventilating the collieries in Northumberland, which are moderately troubled with inflammable air. At

* Burat Géologie appliquée, 1846, p. 472.

page 405 of the same volume, he follows up the first communication by a description of the more elaborate process, as practised in Northumberland, of ventilating fiery collieries. We can do little more here than refer the reader to those articles, and to the instructive diagrams which accompany them. Our description would be unintelligible without the elaborate draughts which are necessary to elucidate the whole process.

The object aimed at by this system is by one series of channels to ramify, through every part of a mine, currents of respirable air, while by another series to withdraw from it and to discharge at the surface the impure air and inflammable or deleterious gases.

Mr. Dunn observes, that until late years the said current of impure air was kept as much as possible together or united; and it was no uncommon circumstance to have it travel twenty or thirty miles before reaching the upcast pit, and then loaded with gases, which steamed from the candle, and even the furnace fire, in thick vapours and flakes of blue flame, alarmingly visible to the naked eye. But, in modern practice, these currents of air are divided and subdivided in countless branches, so as to prevent the air which becomes adulterated in one quarter, from spreading the contagion among the workmen of another. They are conducted through passages either adopted for the purpose, or provided by anticipation in the laying out of the works. To guard against the dangerous influx of gas during the working of pillars, and in order to obviate the danger at the furnace, a "dumb drift" is provided, sloping up into the shaft some fathoms above the furnace, at which point the inflammable air effects a junction with the general air of the pit, and is carried upwards in safety, so that the furnace may be blazing below with good and secure air, and a perfectly inflammable portion may be coming in from above. (See the diagram, page lxii.)

The fall of the barometer is a sure presage of increasing discharge of inflammable gas; for when the barometer stands steadily,—say at 29°—and the pressure is uniform, nothing exudes but the ordinary "makings" of the mine:—but when a sudden fall of the barometer portends a lightening of atmosphere, and consequently a change in the counterpoising pressure upon the orifices whence the gas escapes, or upon the main body accumulated in the wastes, then it is that extraordinary eruptions take place,—enough to overpower and adulterate even the main current of air, and consequently to subject the mine to explosion.

"Blowers" are sometimes met with in the coal, but more generally in the stone, and contiguous to the fissures of dykes. They originate in the clinks or crevices and other receptacles, which, being filled with inflammable air under high compression, are discharged momentarily, and without previous warning. They are often known to endure for many years; although, generally, they decline as the supply of pent-up gas is exhausted. Many very calamitous events have arisen from the miners unexpectedly coming in contact with these blowers; for the discharge is so sudden that the general air-course, although previously safe and satisfactory, becomes, in the course of a few minutes a mass of inflammability, and that without time being allowed to notify the workmen or to prevent an explosion.

In many collieries, but especially those of the north of England, an action is going on whereby cavities are formed in the roofs of old worked seams, by a portion of the roof giving way, and forming a dome or inverted cauldron. These cavities form dangerous receptacles or reservoirs in which the carburetted hydrogen collects in large quantities, and renders the mine

liable to frequent explosion, especially during periods of the change of density in the atmosphere. These cavities are locally termed *goaves*.*

In 1839 was appointed a committee, called "the South Shields Committee," immediately after the explosion of the Hilda pit, South Shields, in which fifty-two lives were lost. The report of this committee was first published in 1843, and it has been affirmed that it may with every propriety, be extolled as a monument of ability and perseverance.† We make a few extracts.

Safety Lamps.—Such is the immense abundance of *fire-damp* in most of the northern mines, that to obtain a natural light, nothing more is necessary than to bore a small hole in the coal seam, insert a tube, and a perpetual flame may be obtained. From the report, it appears that in twenty years, upwards of 680 miners were destroyed by this dreadful means, in the district of the Tyne and Wear alone. The various kinds of safety lamps are investigated, and the reporters give, as their opinion, that the lamps most to be relied upon in mines charged with the destructive gas, are those on the principle of Clanny in England, and Mueseler in Belgium. Even with these the utmost attention must be always paid to their condition; the gauze examined daily, and every part of their construction ascertained to be perfect; the workmen to be warned never to continue working in an inflammable atmosphere, with an overheated lamp; and that, instead of impressing them with the idea that they are perfectly safe instruments, they should be convinced that a reliance on lamps is fatal error, and that no mere safety lamp, however ingenious, is, of itself, sufficient to secure a fiery mine from explosion.

Ventilation.—When it is considered that the explosions are always from a very limited portion of the mine, and that the air has commonly not a motion of more than three-fourths of a mile per hour, in the greatest part of the mine, it is matter of surprise that these lamentable occurrences, instead of being occasional, are not incessant and overwhelming. Living thus always on the verge of destruction, it has excited, among the officers and men

* *Glossary* of local mining phrases, employed in the Northumberland collieries, used by Mr. M. Dunn, in the Mining Journal, 1840.

Boards—principal working places, five yards wide.
Drifts—leading places, (galleries) in the direction of the boards.
Headways—the course of passages at right angles to the boards.
Winning headways—preparatory leading places, two yards wide.
Stentings—the holings between the winning headways.
Rolley-ways or *roll-ways*—main horse-roads to the distant workings, six feet high.
Pillar—the whole coal left during the first working.
Stoppings—brick wallings to force the air to the parts required.
Waste—the mine once worked over, and pillars standing.
Hydrogen or *inflammable gas*—lighter than common air.
Choke damp or *carbonic acid gas*—heavier than common air.
Brattice—temporary partitions of slit deal, to ventilate the leading places.
Blowers—orifices in coal or stone, leading a constant stream of inflammable gas, attended with a great noise—hence the derivation of the name.
Goaf—the cavities which result from the falling down of portions of the roof, and in which fire damp accumulates.
Creep—where the pillars or *sill* give way, under the superincumbent strata.
Air courses—principal passages, [thirty feet area] along which the air is conveyed, and in which the standard quantity is taken to be upwards of two thousand cubic feet per minute.
Brattices—wooden partitions to direct the currents of air in the system of ventilation.
Intake drift—the passage through which the current of pure air circulates.
Return drift—that by which the impure air is withdrawn.
Dumb drift—for the passage of the deleterious gases.
Upcast pit—the shaft by which the foul air ascends, and is occupied by the ventilating furnace.
Downcast pit—that by which the atmospheric air descends into the workings.

† Mining Journal, February, 1843.

in the mines, a continual watchfulness and knowledge of dangerous symptoms that alone enable them to proceed with any degree of safety in such a situation, but in which, on the smallest error, or a contingency unforeseen, as a boy at sleep or at play, a heated lamp, a broken wire, a sudden eruption of gas, or change in the wind, or a sudden pressure of the atmosphere, whether from the falling of parts of the roof or otherwise, the bounds of safety can no longer be preserved; but tremblingly alive to their danger, they are plunged, unresisting victims into the abyss.

In regard to indications by means of instruments, the report states that "the combined indications of the barometer, thermometer and wind, tell the state of a mine with the greatest nicety. When the barometer indicates a fall, the thermometer a rise, and the wind blows from the E. S. E, or south, an ordinary fiery colliery will be certain to pass rapidly into a state of great danger.

VENTILATION OF COLLIERIES, IN SCOTLAND AND THE NORTH OF ENGLAND.

A report was issued, in 1847, by Mr. Tremenheere, the commissioner appointed under the provisions of the act of the 5 and 6 of Victoria, in relation to the mining population of Scotland and the north of England. This and other previous reports have formed the subject of an able article in the North British Review, for November, 1847. We take the liberty of quoting, somewhat irregularly, the substance of a portion of that article.

"Although some of the principal collieries in Scotland are pretty well ventilated, yet it must be admitted that, taken as a whole, the arrangements connected with ventilation in Scotland are, as compared with England, in a very imperfect state. Happily, our mines are almost entirely free from that dangerous element which so frequently produces such awful havoc and devastation to our neighbours in the south. In this respect, therefore, our necessities have not required us to be so particular in carrying fresh air to the mines. Hitherto, most of the mining operations in Scotland have been situated within a reasonable distance from the surface, and the ease with which one pit could be sunk, to relieve the workings of another, superseded the necessity for great outlay in connection with ventilation, and to some extent caused it to be overlooked, and a matter of indifference. In some of the old mining districts, the workings are now extending to a great depth, and the method of ventilation is assuming the most important aspect, and is conducted on the most improved principles; but at the small country collieries, when sinking a new pit, little preparation is made, even now, to have it properly ventilated.

"Accordingly, for several weeks—some seasons, even months, during a continuance of warm weather in summer, the colliers at such places are either partially or altogether idle; the extent of their work being regulated by the state of the atmosphere. The irregularities occasioned by this imperfect ventilation tell very materially both on the profits of the coal master and the incomes of the men, and ultimately on the price of coal in the market, besides doing terrible injury to the health of the people employed, by causing them to breathe in an impure atmosphere. The persons in charge of such works have generally not only a limited education, but possess very limited means of observation; and to them the advice of a properly qualified inspector will be an incalculable boon.

"In respect of Scotland, therefore, the way for an inspector is perfectly

clear, and his appointment may be the means of doing much good in other departments as well as that of ventilation. But what shall we say of England, the scene of so many terrible calamities? That which has baffled the ingenuity and skill of the most talented and accomplished coal-viewers that the world ever saw, such as the late Mr. Buddle, and has proved the ingenious scientific theory of Messrs. Faraday and Lyell to be impracticable, is not likely to be controlled by a government inspector of mines. We have often felt oppressed and overpowered at the thought, that the mightiest efforts of man could not prevent these awful explosions, which cause such a sacrifice of human life. If it were possible to get at the immediate cause, some hope might be entertained of at least mitigating the evil; but from the scene of those accidents no one has ever returned to tell the truth.

"The system of ventilation pursued at the collieries in Northumberland and Durham, where most of these explosions occur, is of the most perfect and complete kind, and entirely in accordance with the principles of scientific truth. But, however sound the principles on which the ventilation is conducted, practice declares that there is a limit to the distance to which atmospheric air can be conveyed with safety underground, from the impurities it mixes with on its way; and however much the question may be avoided, by those who have capital invested in the deep collieries, to this it must come at last,—more openings must be made from the surface; more pits must be sunk. The question must be brought to this practical issue,—whether is capital or human life to be sacrificed? and when it does appear in this shape before the British Parliament, we do not fear the result.

"It is stated by Messrs. Faraday and Lyell, in their report on the explosion which occurred at the Haswell collieries in 1844, that 'when attending the late inquest, we were much struck with the fact, that more than half of the pitmen who gave evidence, were unable to write, or even to sign their names as witnesses.'

"It is a well ascertained fact, that accidents from fire damp have generally occurred with a low barometer; and when we consider that a fall to a very small extent will render a place, which it was safe to work in at night, perfectly unsafe and dangerous in the morning, we cannot help feeling that there is something grievously wrong in allowing men, who cannot write their names, to have any thing to do with ventilation at all."

MEDICAL TREATMENT AFTER EXPLOSION.

The report of the South Shields committee, previously referred to, goes at considerable length into an explanation of the condition in which miners meet their death by explosions; the proportionate quantities of the gases, which create them, and the nature of the *after-damp*.

This after-damp is formed of

8 parts of nitrogen, having a specific gravity of 0.9722.
2 parts of aqueous vapour.
1 part of carbonic acid gas, specific gravity, 1.5277.

The latter takes its place towards the bottom of the passages, and, probably, extends little more than six inches high. Hence it is inferred that when the men, after explosion, if not struck down at once by it, attempt to leave the mine through an atmosphere of after-damp, they are at first rendered partially insensible by the nitrogen, which has been substituted for atmospheric air, and then, falling, they come in contact with a still more deleterious gas, a positive poison, [the carbonic acid gas], which having

inhaled to a small extent, they pass rapidly into a state of asphyxia, owing to the state to which their systems have been previously reduced.

Two practical inferences are thus deduced—

1. Where carbonic acid gas is abundant, the lights are instantaneously extinguished, and burn with a dull red flame as they approach it; on these indications the miner is warned to retire, as here *flame is extinguished before life;* but when there is a large admixture of nitrogen, the lamp continues to burn, as in sulphuretted hydrogen, even when the miner has been struck down—life in this case *being extinguished before flame.*

2d. That asphyxia, arising from nitrogen, and *completed* by carbonic acid gas, might probably indicate a different system of medical treatment from that hitherto pursued. The symptoms of asphyxia,—always easy to be known,—are the sudden cessation of respiration; of the pulsations of the heart, and of the action of all sensitive functions; the countenance is swollen, and marked with reddish spots; the eyes become protruded, the features decomposed, and the face often livid.

It is necessary to succour an asphyxed person with the utmost promptitude, and to continue the remedies with perseverance, until it is certain that life is completely extinguished. The following general remedies should be adopted: immediate removal into fresh air; undress and dash the body with cold water; endeavour to make the patient swallow water slightly acidulated with vinegar; clysters of two-thirds water and one-third vinegar, to be followed by others of a strong solution of common salt, or of senna and epsom salts; introduce air into the lungs by blowing with a nozzle of a bellows, into one of the nostrils, and compressing the other with the finger. Should these means not produce the desired effect, and the body still retain its natural warmth, recourse must be had to blood-letting, the necessity of which will be clearly indicated by the red face, swollen lips, and eyes protruding. If blood fails to flow from the jugular vein, an attempt should be made on the foot; the last effort which can be made is to make an opening in the trachea, and introduce air to the lungs by means of a small pipe and a pair of bellows. These various remedies should be applied with the greatest promptness. The absence of the beating of the pulse, and the want of respiration are not certain signs of death, nor should all be regarded as dead whose breath or pulmonary transpiration does not bedim the brightness of glass; nor those whose members appear stiff and insensible. In giving these brief instructions, the committee hope that some of them may be judiciously practised, instead of the injurious plans sometimes adopted, until the arrival of a medical practitioner, who will thus find the patient prepared, uninjured, for his professional skill, and his object facilitated, not obstructed, by the previous treatment he has received.

DRAINAGE OF COAL MINES.

In the mines which are situated in hilly or mountainous countries, it is generally easy to intersect the beds by galleries which commence at the lower part of some valleys; these galleries furnish a natural outlet for the waters of all the works which are above their level, and on this account are called in France *galeries d'écoulement*, or drainage galleries; in England, Wales and the United States, *adits*, or *adit levels*, and occasionally *drifts* and tunnels: but the word adit is the most distinctive of its object and uses.

The advantages of these adits are numerous, and have often decided the undertaking of long and expensive works.

In fact, they are not only preferable to mechanical means of drainage, because when once made they require very little management or attention, but in giving issue to the upper waters, they also create a moving power which can be employed in the service of extraction, or in the draining of the lower works; finally, they furnish the most economical means for the other services of the mine, such as the forced ventilation, or the extraction of the substances mined.

An adit level can often be so arranged as to serve, at the same time, the working of several veins. On account of all these united advantages, there has been undertaken in the district of Schemnitz, in Hungary, a gallery of 20,000 yards in length, or about 11½ miles, designed for the use of the principal mines of the district, under the double service of draining the waters, of the carriage or gangway, and the creation of mechanical powers; it has been, besides, directed with a view to explore the ground for the discovery of new veins. At the Hartz, the great "galerie d'écoulement" of the mines of Clausthal, which is 13,000 yards in length, serves equally for a great number of mines, in different branches of the service. The use of these galleries is common in the countries where the mines are numerous and near together.

In relation to pumps, and the varieties of hydraulic machines employed in mines, for the purposes of drainage, we must refer to the various authorities who have written either in England or on the continent of Europe on this important subject, and which, moreover, would require the aid of numerous illustrations to render any description intelligible.

At page 445 of the present work is an account of the machine for draining the lignite mines of Rocher-Bleu, Bouches-de-Rhône, in France.

In the third volume of the Mining Review, p. 302, our readers will find a description of the pumps used in the deep mines of Cornwall, by Mr. John Taylor. The machinery brought to such perfection, and operating with so much economy and simplicity, is celebrated throughout the world. At the period of this communication, the steam engines of the district performed the work of 44,000 horses.

TRACING OF COAL BEDS IN THE ANTHRACITE DISTRICTS OF PENNSYLVANIA.

In these basins, where the outcrops of the coal seams almost always present themselves at a very high angle, they are in general readily traced, by the subordinate depressions which may be observed ranging longitudinally along the sloping sides of the mountain ridges; pursuing, of course, the direction or strike of the strata. These depressions are obviously formed by the removal of the decomposable and soft materials of the coal seams; that is to say, the shales, the under-clay, and the coal itself, and they are conspicuously in contrast with the rocky siliceous beds which flank them, and which, being composed of less destructible materials, have longer resisted the atmospheric agencies. Thus, in numberless instances, these longitudinal grooves afford an unerring clue to the subjacent beds of anthracite. In the great bituminous coal region of the Alleghany mountains, where the strata closely approximate to a horizontal state, such guides as those we have mentioned can, of course, have no existence, and we have there to seek for other phenomena which may indicate the presence of coal. Happily these are so abundant, that no coal region in the world, probably, presents more ready facilities for the ascertainment of what lies at so insignificant a depth beneath the surface.

To return to the more disturbed region which is occupied by anthracite, in Pennsylvania. The disposition of the outcrops, to which we have alluded, materially influences the physical features of these coal districts, and modifies the contour of the surface by a numerous succession of terraces, steps, or benches, on the inner slopes of the mountains, facing the centres of the basins. Those who have ascended, from either side, the long parallel mountains which border the southern coal region of Schuylkill county, to the height of 1350 feet above the Susquehanna river, and more than 1650 feet above tide-water level, need not to be reminded of these characteristic details.

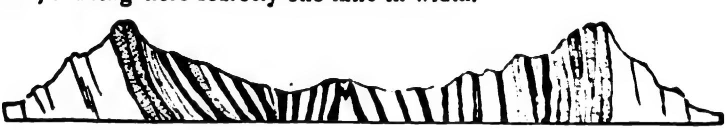
Between the external margins of the principal coal basins of Pennsylvania, subordinate axes of elevation are of frequent occurrence. Even the undulations of the surface between these limits are all attributable to these minor axes, and correspond, in great measure, with the local inclination of the upheaved stratification beneath. These undulations of groups of coal seams, so important to the proprietor, yet whose existence, until of late years, was scarcely suspected, are daily becoming more familiar to us, as the progress of development and practical investigation gradually advances.

The long narrow troughs, of which there are so many in central Pennsylvania, owe their contour to parallel synclinal axes, which present highly inclined or vertical coal beds; and occasionally even exhibit the strata of one of their sides tilted or leaning over so much that their inclination becomes almost parallel to, or conformable with, those of the opposite side the basin.

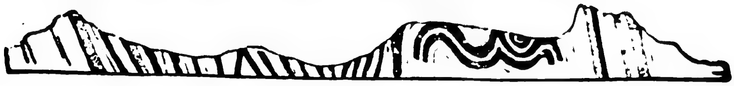
In proportion as the anthracite basins become wider, their interior is the more disturbed or broken by undulations, consisting of one, two or three subordinate axes, each maintaining itself for a space as a parallel inferior ridge, and thus interrupting the general trough-like arrangement of the stratification. It is to be expected that the carboniferous beds in the vicinity of the centres of these synclinal axes are liable to be too much crushed to permit an advantageous working of their contents.

The southern anthracite region, in particular, furnishes numerous instances of the modified arrangement of which we speak, and we might introduce several illustrations from our own observation, which would exemplify the extent of the forces to which the anthracite country has been subjected, in the area between the Lehigh and the Susquehanna.

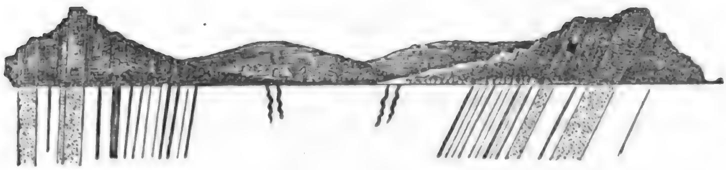
Beginning near the eastern extremity, at Nesquehoning, we see the ordinary basin-form arrangement modified by an upheaving or saddle in its centre, it being here scarcely one mile in width.



Next westward is a section in the meridian of the Mauch Chunk summit mines, where the basin has now expanded to almost double the breadth that it occupied at Nesquehoning. The structure of the interior is now considerably complicated, and the enlarged breadth allows of a triplication at least of the coal series. So confused is its aspect at this point that we are by no means certain that our section embraces all the details.



Further westward we have the very interesting and magnificent transverse section formed by the stream of the Little Schuylkill, at Tamaqua, where the basin has again contracted to the simple synclinal axis, of scarcely one mile in breadth.

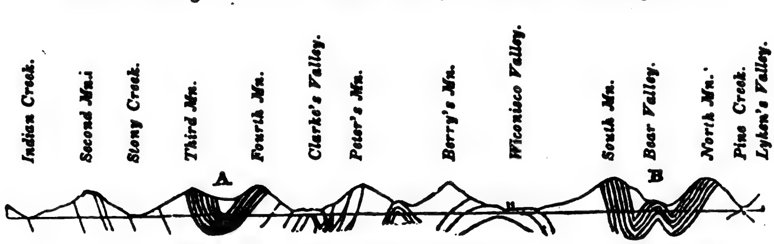


Our figure exhibits this section with the accuracy resulting from an original survey, and it is the more memorable from the presence of a particular seam in the Sharp Mountain, which is worked to the breadth or thickness of no less than seventy feet.

At Pottsville, the same region has widened to the extent of about five miles, affording, by the repetition of the coal beds, a vast industrial area; and at the head waters of the Swatara river there is now a breadth of no less than six miles. In the Pinegrove coal district we have at least three miles of breadth. Thus we perceive that in proportion to the space or breadth between the geological margins of the Schuylkill coal-field, so is the frequency of the undulations, the number of anticlinal elevations or axes, and the consequent repetitions of the same series of coal seams.

Westward of the Swatara or Pinegrove coal region, it bifurcates and stretches, with diminished breadth, for many miles towards the Susquehanna. The geological structure of these two forks is illustrated by the above diagram.

Section showing the North and South Forks of the Southern Coal Region, Pa.



Rausch Gap. *Scale three miles to an inch.* *Bear Valley Gap.*

The figure represents a cross section, in a north and south direction, of a part of the coal region near the western boundary of Schuylkill county, crossing both the forks of that basin. It shows, in the first place, at A, the simple synclinal axis which forms the south-western fork of the region, and its nearly vertical strata on the southern margin of Sharp Mountain. On the same meridian, crossing the north fork at B, is a specimen of more complicated structure; not a simple anticlinal axis, but a trough which exhibits a subordinate anticlinal ridge, or central saddle at B.

The enlarged details of the portion A, are shown in the sketch below, a few miles to the eastward, at Black Spring Gap.

We have been led somewhat astray from our purpose of devoting this section to the consideration of the usual means of tracing the coal seams along their outcrops in the anthracite region of Pennsylvania. We have previously remarked that in the horizontal beds of the bituminous coal-fields of North America, their position was very readily ascertained. We showed also that in the highly inclined anthracite areas, the range of the outcrops was ordinarily distinguishable by parallel depressions along the mountain flanks of the basins.

During our own investigations we have remarked that the true positions of those veins which had their bassets on the slopes of the mountains were, in most cases, rendered obscure by the curvatures of the crops, almost at right angles to the true inclination of the veins. We ascribe this to the atmospheric agency, operating to a given depth below the surface, and to the mechanical influence of surface waters, decomposition, the sliding down of the higher masses, &c. In every instance which has come under our observation, in relation to the outcropping of coal seams on these slopes, we have perceived the manifestation of the like influences, which have deflected the "wash" or decomposed materials of the coal veins from their true courses and thrown them over among the alluvial detritus, generally in a curve, as shown by the next figure, which is merely the representative of numerous corresponding cases.

Coal Crops on the Fourth Mountain.

ON THE MAPS OR PLANS OF MINES.

In every working a good plan of the mine is of great utility; it is above all indispensable when the subterranean works are considerably developed. In fact, it is necessary to maintain the works in the limits of the property, in order to avoid contests with neighbouring owners, and there always exist some points from which it is necessary to keep removed, under risk of the greatest dangers. Finally, when it is suggested to effect a junction with a point, fixed beforehand by a pit or gallery; if there was not a plan constructed with precision, we should run the risk of missing the object, and of making costly works to no purpose.

The drawing of the plans of mines presents great difficulties. The mines being composed of crooked passages, isolated one from the other, how should we determine, singly, the form and the position of each of them, and render them conformable to the plans of the whole? These difficulties are still increasing from the necessity of working in obscure galleries, often low and difficult of access. To construct correctly a map of the works which only communicate with the surface, by sinuous galleries or by shafts, it is absolutely necessary to have recourse to the needle. The dial, or mining compass, is composed of a magnetic needle tinted with blue steel at the north point, and balanced on a cap of agate.

The mining compass is suspended from the middle of two axes or spindles, *tourillons*, upon the support of the brackets, *crochets;* the line N and S corresponding with the axis of the crochet. If then, after having strongly held a cord or copper wire, following the axis of the gallery of which the direction is required, the compass be suspended at this cord, the deviation of the needle from the north and south line, will give the angle of the direction. In order to facilitate the reading of this course, the letters E. and W. are commonly transposed, so that the true point of the course may be read in degrees and minutes, by means of the figure which approaches the nearest to the blue point. This method is also applicable to the compass which is carried in the hand, and appears to be generally in use in Germany and France. The difficulty of reading off, with sufficient exactness with an uncertain light, and in positions often incommodious, the angles marked by the needle which oscillates during a long time, is one of the many obstacles to the perfect accuracy of the observations, and it is admitted that by this method an observation cannot be taken with greater nicety than a quarter of a degree, or fifteen minutes.

In mines of the magnetic oxide of iron, where the action of the needle is deranged by its proximity to the mineral, the compass cannot be employed, and the graphometer is used. A theodolite, for subterranean service, is also adopted in France, with which plans and surveys of mines can be constructed with equal celerity as with the compass, and in a more exact manner.

MINE SURVEYING.

In England the usual surveys in mines of all descriptions were made with the dial. The most useful treatise on the art and on the practice of this instrument, is that of Mr. Budge, of Cornwall,* an eminent mine surveyor. Although constantly employing the dial in his business, he, from the first, by no means viewed it as the most accurate that can be employed, and remarks, "There doubtless are instruments much better adapted to the work, both for speed and accuracy, than the dial; and it is matter of surprise that they have not been more generally introduced in our mines: of these instruments the theodolite certainly stands unrivalled, for taking both horizontal and vertical angles."

In the second edition of this work, after a lapse of twenty years, the author devotes a section to the subject of "surveying without the magnetic needle." This is a valuable modern discovery; and as the general introduction of iron railways and tram roads in mines drove the surveyor to seek some substitute for the needle, which the attraction of iron rendered useless, he has happily succeeded. The best circumferentors are now made with

* The Practical Miner's Guide, by J. Budge, second edition, 1845.

an external graduation and vernier scale, on the theodolite principle, on purpose for the performance of this work.

The author enters into all the necessary details for proceeding with the observations ascertained by this improved instrument, and for protracting and calculating the work thus performed.

IRON ORE OF THE COAL FORMATION.

In the coal formation, iron only exists in the state of carbonate: it is generally concentrated in particular beds of a basin, and upon a much more limited superficies than that of the beds themselves. The usual form of the carbonate of iron of the coal series is that of oval or kidney shaped balls,—*rognons*, having a brown or greyish fracture; it is a mixture, more or less rich, of clay, and carbonate of iron. These balls occur stratified in the argillaceous beds. They appear to be assembled and precipitated during periods of repose, when the waters deposited at the same time the argillaceous particles with which they were charged. These spheroidal concretions or rognons, in consequence of their mixture with clay, are often arranged in concentric laminæ, and frequently also present in their centre, a nodule of clay or of pyrites; sometimes even a fossil substance,—nuclei, which appear to have attracted around them the chemical precipitation.

The position of the nodules of lithoide carbonate of iron is in strata parallel to the coal seams. This is the case at the mine of Treuil, in France, and almost every coal-field in England presents a similar deposition. In those of North America, we find a smaller amount of argillaceous carbonate of iron so interstratified with the coal beds, than in Europe, and the instances where iron works are supplied from these sources in America, at the present day, are but rare.

In the coal basins of England, the carbonate of iron is almost always found in the same beds, extending over very large districts. There are two large beds of ferriferous clay in the Dudley basin,* and sixteen or more in the great anthracite district of South Wales.

According to M. Burat, the numerous coal basins of France are far from containing the carbonate of iron in the same abundance as those of England. Few of the argillaceous beds contain these balls, and still more seldom do they contain those which are concentrically formed. At Saint Etienne, for instance, there exist two which furnish in the concession of Treuil, flattened rognons of fair quality, and contribute to supply the furnaces of Janon; but in the other concessions, the balls are not recognized in the equivalent beds, or they are so small as to be neglected. At some other points, the carbonate of iron appears in great abundance, but with very different characters: at the mine of Cros, it penetrates the entire beds of clay, of one or two yards thickness, and gives to that rock a remarkable solidity and density. But these massive beds are much more impure than the beds with disseminated nodules: besides a large proportion of clay, they also contain pyrites and

* The Dudley coal-field is remarkable as being one of the earliest positions where the argillaceous iron was smelted by means of pit-coal. The experiment was made by the founder of the noble house of Dudley and Ward, who published an account of it in the time of Charles II. He states that in a large stone furnace, twenty-seven feet square, he made seven tons of iron per week, "near which furnace the author discovered many new coal mines, ten yards thick, and iron mines underneath, which coal-works having brought into perfection, the author was by force thrown out of them, and the bellows of his new furnace and invention by riotous persons cut in pieces, to his no small prejudice, and loss of his invention of making iron with pit-coal."

precipitations of dark silex, to such an extent that the working which ought to have been developed, remains almost unproductive.

The coal basin of Aubin, in France, contains the iron ore in the most abundance. It exists, in the first instance, in balls in the beds of clay which accompany the coal, and, as at Saint Etienne, under that form it is the purest mineral. In the other cases, it constitutes a somewhat schistose bed of from three to fifteen feet thickness, which appears to extend under the greater part of the coal area. This bed is remarkable, inasmuch as it presents at several points a series of contractions and enlargements, which constitute the arrangement called *en chapelet;* like a string or chaplet of beads, —an arrangement very frequent in all the substances which result from chemical precipitations in sedimentary waters, such, for instance, as is often presented by the flints in chalk. This structure is, in other respects, independent of the other accidents, faults or disturbances, which equally affect this bed as those of the coal series. The kidney ores and the bed of stony carbonate of iron are worked at several places in the basin, and supply the high furnaces of Decazeville.

There are but very few basins which do not possess beds analogous to the argillaceous carbonate of iron; but they are in such slight amount, that there are no other workings than those of the two basins of Saint Etienne and Aubin, which we have just mentioned.

On the whole, if we compare the beds of lithoide carbonate of iron with the mass of coal formations, we see that their existence, but little developed, although frequent, must only be considered an accidental circumstance. It is equally worthy of remark, that, in every case where there was a formation of coal in the series subsequent to the true coal, viz., the ferruginous elements have anew resumed the composition and the characteristic aspect of this epoch.

Thus in the coals and the shales with vegetable impressions of the epoch of the lias of Yorkshire, we find the carbonate of iron stratified in balls; whilst, in the same formations, when their appearance is in the normal state, the ferruginous infiltrations appear only in the state of oxides.

These variations of composition in the ferriferous minerals, establish no real difference in the origin to which they may be attributed. They tend merely to demonstrate that the iron, collected at certain intermittent epochs and at isolated points, most commonly in the state of oxides, has undergone through the influences of the carboniferous epoch, a mineralogical transformation. The coal period appears generally to have been a period of tranquil deposits. It is, then, natural to find that in it the ferruginous infiltrations are more concentrated than in the periods of the old red sandstone, of the new red sandstone, and even of the trias, where the products of these infiltrations are blended with the general materials of the deposit.

We have already remarked, that these infiltrations only become valuable according to their concentration: the formations before mentioned, so highly coloured by the per-oxide of iron, contain, perhaps, altogether much more iron than the coal formation; but, in the latter, it is collected together, and often possesses a concentration of 30 and 40 per cent., constituting serviceable beds. In the red or mottled sandstone formations, we find iron everywhere; but the concentrations even amounting to ten per cent. are but rare exceptions. The presence of the iron would then be scarcely remarked, if the glaring colour of these red and variegated formations did not contrast with the gray and dark rocks of the coal deposits which they cover, and with the white and greenish colours of the thick limestones and clays which are above them.*

* Burat.—Géologie applique, p. 108.

SECTION III.

FOSSIL BOTANY AND GEOLOGICAL DISTRIBUTION OF VEGETABLE REMAINS.

In intimate connection with the matter of the present volume, a knowledge of the forms, the botanical classification, the geological arrangement of the vegetable remains of an ancient world, seems to be almost indispensable. It embraces facts, at least, sufficiently valuable, to ensure for it, as a collateral branch of natural science, a conspicuous section of this book. Independently of its usefulness, there is a never failing interest attached to such an investigation, which enables us to trace the history, as it were, the past condition, the present adaptation of the primeval flora;—that magnificent vegetation which, amidst the mutations of our planet, yet survives for our use; its characters changed, it is true, but only to become more serviceable to man.

A happy provision was it that secured for the ultimate advantage of the human race, ages before its appearance upon the globe, the trees of gigantic size, the densely growing shrubs, the most delicate even of the lesser plants —that flora which covered in such profusion the islands and plateaux, and filled the humid valleys, of the early world. A happy provision was it that, amidst the early catastrophes of the earth,—those convulsions which modified its entire surface, overwhelmed its primeval forests, and buried them beneath enormous accumulations of earthy debris, of sediment and of rocky debacle —still perpetuated and matured during the lapse of countless ages, that primitive vegetation, which, finally, in the form of mineral combustibles, we are now busy in exploring, and mining, and appropriating, in a thousand ways, and for a thousand purposes. A happy provision was that—a beneficent one, surely—which at the moment when man is compelled to level the existing forests, to make room for the progress of agriculture, and the cultivation of the present surface, he finds nigh at hand, yet buried beneath that surface, within the shallow basins and woody islands of the antediluvian world, those inexhaustible stores of a combustible now rendered infinitely more precious and effective than that existing vegetable fuel, whose destruction is the inevitable consequence of advancing civilization.

Respecting the wondrous influence which the employment of mineral combustibles has had, even in our own days, upon the whole world, by the acquisition of new forces; by the extension of mechanical powers, of manufacturing capabilities; by the impulse given to the industrial arts, and the creation of new sources of wealth; by rapid and cheap modes of transportation, and enlarged commercial facilities: above all, by the improved condition of the people, we will not here dilate. Abundant evidence of all these will be found in this volume.

FOSSIL BOTANY.

Classification of Plants: their families, classes, and orders.—We shall occasionally have to make mention of the varieties of plants which occur in a fossil state, and which, in common with all other organic remains, are

characteristic of, or distinguish with remarkable precision, every geological epoch. It may save the reader some trouble in referring to elementary books, if we briefly explain here the mode observed in the classification of this fossil vegetation; of which the true coal formation alone contains about four hundred known species.

The system generally adopted by botanists is, that of Jussieu, which is termed the "natural system," in contradistinction to that of Linnæus, which is denominated the "artificial system." Mr. Loudon states that the former method has for its object the arrangement of plants according to their greater or lesser degree of resemblance, both externally and internally.

The *seed* is considered the most important part of the plant; as being destined for its re-production and continuance in the world. The fundamental divisions of this arrangement are, therefore, founded on the characters of seeds.

The first grand division is derived from the presence or absence of seed-lobes; the next on the union or division of the seed-lobes in such as have them. Thus we have the three primitive divisions of *Cotyledoneæ, Monocotyledoneæ*, and *Acotyledoneæ*.*

Every one allows, M. Decandolle observes, that plants which resemble each other by their exterior forms, resemble each other also in their internal structure; their mode of vegetation and their properties. The three primitive divisions are divided by this botanist into eleven classes; and, according to the Jussieuan method, all vegetables are furnished with seeds which arrange themselves under one or other of the following heads.

COTYLEDONEÆ.

Exogenous stems.—Furnished with two or more cotyledons, or seed-lobes; as the bean or the acorn; having a central column or pith, and an external band called the bark, the two being connected by medullary rays; this division being thus subdivided into I. Dicotyledons; II. Monocotyledons; III. Acotyledons.

I. DICOTYLEDONEÆ.

Having the calyx and corolla distinct.		Having the calyx and corolla, forming only a single envelope.	
Six classes and eighty-three orders.		One class,—*Monochlamydeæ*.	
		Seventeen orders.	
Ranunculaceæ,	Samaroubeæ,	Plumbagineæ,	Laurinæ,
Magnoliaceæ,	Ochriaceæ,	Plantagineæ,	Santalaceæ,
Papaveraceæ,	Terrebinthaceæ,	Euphorbiacæ,	Urticeæ,
Cruciferæ,	Legumenoseæ,	Amentaceæ, &c.	Coniferæ,
Caryophylleæ,	Oleineæ,		
Linneæ, &c.	Jasmineæ, &c.		
	Cacti, Ericæ, &c.		
embracing 1255 genera, and 8612 species.		comprising 172 genera, and 1249 species.	
Beside 53 genera and 71 species whose orders are not fully determined.			

Fossil dicotyledonous plants of the coal formation.—Until recently the fossilized dicotyledones were supposed to occur not lower than the Tilgate or Upper Oolite beds. The coniferæ also were considered as not older than the oolite series. But recent investigations, by distinguished naturalists, have shown that these groups formed the greater portion of the coal

* London Encyclopedia of Gardening, p. 113.

vegetation. Thus, for instance, some fossil trees, which were discovered rooted in a coal bed in the Lancashire coal-field, were identified by Mr. Bowman as sigillariæ,* while at the same time he showed that medullary rays and coniferous structure existed; a fact which M. A. Brongniart, Lindley and Hutton, Humboldt and others have fully corroborated. Hence, it seems that botanists are inclined to withdraw the Sigillaria altogether from the family of tree ferns, with which they have been heretofore classed, and even from the Endogenous class, or Monocotyledones. We are therefore to understand that the Sigillaria is a dicotyledonous and coniferous plant, and that the arborescent ferns, Caulopteræ, belong to the monocotyledonous group.

Among the dicotyledonous plants of the coal formation are now arranged

Sigillaria, 59 species,	Asterophillites,
Stigmaria, 30 "	Annularia,
Calamites, 18 "	Sphenophyltum,
Cycadea,	Coniferæ.
Lepidofloyas,	

II. MONOCOTYLEDONEÆ.

Endogenous Stems—furnished with only one cotyledon or seed lobe, [as the lily,] and having neither pith, concentric circles of woody fibre, nor true bark: distinguishable as follows, in the existing series:

Those in which the fructification is visible.	Those in which the fructification is concealed, unknown, or irregular.
One class, *Phanerogameæ.*	One class, *Cryptogameæ.*
25 orders. Cycadeæ, Bromeleæ, Orchidæa, Scitamineæ, &c. Iridea, Lilia, Junceæ, Palmæ, Canneæ, Gramineæ, &c.	5 orders. Naideæ, Equisetaceæ, Marsiliaceæ, Lycopodiaceæ, Filices, Including the arborescent and herbaceous ferns.
338 genera, and 1945 species.	99 genera, and 261 species.

Of doubtful genera, 53 genera and 71 species.

Distribution of Fossil Vegetation.—In a memoir "on the Ancient Flora of the Earth," written some years ago by a contributor to the Edinburgh Philosophical Journal, the author concludes with the following summary:

1st. That among the universally distributed rock formations, [groups] since the first appearance of organic beings, there is not one of them in which the remains of a contemporary land vegetation are not to be observed.

2d. That the different periods of the vegetation of a former age are gradually characterized by the continual entrance of new and always more perfectly organized [?] families of plants; but there is not a complete disappearance of all the species of the preceding periods.

3d. That species of the most perfectly developed class, the dicotyledonous, are first traced in the oldest strata of the *secondary* formations, while they uninterruptedly increase in the successive formations. To similar views Humboldt opposes some objections, particularly in relation to the theory of the supposed† simplicity of the first forms of organic life, and especially the

* Proceedings Geological Society, London, vol. iii. p. 270; also Mantell's Medals of Creation, p. 132.
† Edinburgh Philosophical Journal, January, 1830.

assumption that vegetable life was awakened sooner than animal life upon the face of the old earth.*

With respect to the vegetation of the true coal formation, Sir Alexander Chrichton observed, that every coal country in every part of the world, which has been hitherto examined, abounds in the fossil remains of similar or corresponding vegetables. There is no material variety, let the latitude or longitude or elevation be what they may. Recent examinations of the fossil flora of remote coal beds, such as those of Australia, Van Diemen's Land, and Northern India, would seem to point out some exceptions to the rule heretofore adopted, but the evidence is by no means complete that these fields were really of the true coal period. "Every plant in the present condition of the globe, independently of its natural dwelling-place, has, as it were, a central spot in which it flourishes best; and, considering this spot as the centre of a circle, or rather as a zone, the plant degenerates in proportion as it approaches the limits of this district." The writer goes on to point out a very important circumstance, namely, that there is a difference of mean temperature, at present, of forty-one degrees of heat between the parallels in which coal has been discovered.† Between these, as regards the existing vegetation, the diversity in the genera and species of plants, at present, is very great; so much so, indeed, that there is no resemblance between the floras of the two extreme points. At the time, however, of the true coal formation, it is now admitted that the flora of these two remote parallels was nearly the same, both as to genera and species, and in this respect strongly contrasted with the present condition of things.

Fossil Plants of the class Phanerogameæ.—The monocotyledonous family of this class, in the fossil state, commence in the London clay tertiary formation, and, until lately, were thought not to descend lower in the geological series than the oolites, or the Wealden beds, the Portland oolite and the Lias.

The cycadeæ [Cycas Zamia] form the connecting link between the ferns and the palms, while, according to the authorities last cited, the sigillaires differ not more from the arborescent ferns [Caulopteris,] yet existing, than the stems of the calamites, the bactris, and other arundinaceous palms,‡ which order contains, in the recent state, eighteen genera and twenty-nine species. Zamiæ were very abundant in the oolite period. Eleven species occur in the coal of the Yorkshire oolite alone.

Distribution of the Vestiges of Palms in the Geological Formations.§—Prof. Unger states, *first*, That no vestiges of palms have been detected in the earliest rocks which contain the organic remains of maritime and terrestrial plants.

Second, That palms bore some small part in the vegetation at the period of the *coal formation*. He names four species or forms, two of which occur in the coal schist of Swina, Bohemia, one in sandstone of the Ural Mountains, and one from Rajemahl, North India; also two undescribed species from the coal formation of Silesia.

Third, The flora of the *red sandstone*, above the coal series, although it has been very imperfectly preserved, and its scanty remains but little studied, Unger thinks was not materially different from that of the coal formation. But the fossils of this era, which have been referred to palms, he thinks are very doubtful. In the Quadersandstein, Gœppert found some vestiges in

* Cosmos, A. Von Humboldt.
† This approaches closely to the range we have assigned to the coal formations.
‡ Histoire des Vegetaux Fossiles.
§ American Journal of Science, July, 1846.

Silesia. From the next series, the oolites, the four species of *Carpolythes*, described by Lindley and Hutton, may be mentioned.

Fourth, and finally. In the tertiary, palms reappear, and the number of species far surpass that of all the other formations together.

Subdivision of tertiary positions,—

In the chalk and eocene,	4 species, also fruits.
" miocene	26 species on the European continent.
" pliocene,	4 species, island of Antigua.

Fossil Cryptogameæ.—Many years ago, Count Sternberg noticed that out of one hundred and fifty species of plants belonging to the old coal formation, one hundred and thirty-eight were vascular cryptogamea: soon afterwards M. A. Brongniart stated that the vascular cryptogamous plants had a vast numerical proportion in our great coal-fields; and in fact, even at that early period, he had ascertained that out of two hundred and sixty species, discovered in that formation, two hundred and twenty belonged to this class.

This arrangement has of late received very considerable modifications; chiefly through the aid of a microscopic elucidation of their structure, as we shall proceed to show. Messrs. Lindley and Hutton, A. Brongniart and others, now withdraw the sigillariæ, the stigmariæ and the calamites, from this numerous group; separating them from the associated filices or herbaceous ferns, and the caulopteræ, which only comprise the true arborescent ferns.

The fossil cryptogamous series embraces the following:

	Species.	
Sphenopteris,	36	146 species belonging to the filices or herbaceous ferns, chiefly of the coal beds.
Cyclopteris,	6	
Nevropteris,	28	
Pecopteris,	76	
Caulopteris,	"	The true arborescent ferns.
Equisetaceæ,	"	Some species.
Lycopodiaceæ,	8	48, belonging to lycopodites and club mosses, of the coal formation.
Lepidodendrons,	40	

III. ACOTYLEDONEÆ, OR IMPERFECT.

Vegetable beings composed of a cellular tissue unprovided with vessels, and of which the embryo is without cotyledons. The divisions of this family are as follows:

With leafy expansions and known sexes.	Without leafy expansions, and not of known sexes.
1 Class, Foliaceæ.	1 Class, Aphylleæ.
2 Orders, { Musci or mosses. Hepatica—liverworts.	5 Orders or subsections, { Lichenea-fuci, conferoæ, &c. Hyponyloneæ. Agariceæ, fungi. Algæ, flags. Fungi.
545 species are natives of Great Britain.	About 1350 species natives of Great Britain.

Fucoides, of many species, are exceedingly abundant in the silurian or transition formations, from the coal series down to the primitive rocks. In certain portions of the silurian series of North American rocks, this class

of plants is surprisingly prevalent, and characteristic. The oldest of these formations present us with nothing but cellular-leaved marine plants. Many species of fucoides in the copper slate of Mansfeld.

The prevailing vegetable forms of the chalk formation are those of marine and freshwater plants—fuci and najades.

Of confervæ are three fossil species; of algæ, nine species; and of naides, four species, in the cretaceous group.

Distribution of Fossil Vegetation.—M. Alex. Von Humboldt has stated in a recent work, that it is in the Devonian strata that a few cryptogamic forms of vascular vegetables, equisetaceæ and lycopodiaceæ, are first encountered. After these strata, we arrive at the coal formation, the botanical anatomy of which has made such brilliant progress in recent times. These comprise nearly four hundred species, including in their number not only fern-like cryptogamic plants, and phanerogamous monocotyledons, grasses, yucca-like lilaceous vegetables, and palms, but also gynospermic dicotyledons, coniferæ and cycadeæ. Fossil coniferæ have been found in the old coal formation of England and Upper Silesia; while cycadeæ are contained in that of Radnitz, in Bohemia, and Königshütte, in Upper Silesia. The cycadeæ attain their maximum in the Keupfer strata and the lias, where about twenty different forms make their appearance.

The lignitic or brown coal strata, which are at present in every one of the divisions of the tertiary period, amongst the earliest forms of cryptogamic land plants, exhibit a few palms, many coniferæ with distinct annual rings, and frondiferous trees, of more or less decided tropical character. In the middle tertiary period we observe the complete recurrence of the palms and cycadeans; and in the last members of this epoch, at length, strong resemblances to our present flora. We come suddenly upon our pines and firs; our cupuliferous tribes; our planes, and our poplars. The dicotyledonous stems of the lignites are frequently distinguished by gigantic thickness and vast age. A trunk was found near Bonn, in which Noggerath counted 792 annual rings.

With relation to coal vegetation, M. Humboldt remarked that where several series of coal strata lie over one another, the genera and species are not always mixed; they are rather, and for the major part, generically arranged, so that only lycopodites and certain ferns occur in one series of beds, and stigmariæ and sigillariæ in another.*

In elucidation of the progress made in fossil botanical discovery, Mr. Adolphe Brongniart† has lately observed that the further we proceed in the series of ages towards the earliest geological periods, the further are we removed from the actual creation, and the greater do the differences between the living and fossil beings become.

Thus, most of the fossil plants of the tertiary strata belong to *genera* in actual existence, and merely present specific differences.

Those of the secondary strata may, undoubtedly, almost always be referred to known *families*, but appear in most cases, to require the formation of new genera.

Lastly, in the older strata, particularly in the coal formations, many of the fossil plants cannot be classed in families at present existing, and ought to constitute new *groups* of equal importance.

He adds that new and hitherto very rare specimens, which have been collected and carefully studied in England, Germany, and France, have

* Cosmos.

† Comptes Rendu, Dec. 29th, 1845—and Annual and Mag. Nat. Hist., February, 1846.

caused important changes relative to the plants which he had previously considered as vascular cryptogamia. This advance is owing to the discovery of portions of stems of these plants having the internal structure in a state of preservation. They have shown that the *sigillariæ*, stigmariæ, and probably most of the calamites, are not plants nearly related to the *ferns*, *lycopodia*, and *equiseta*, but to distinct families of the dicotyledonous gymnospermous group, more nearly approaching the *coniferæ* and *cycadeæ*.

Hence, at the period of the coal formation, vegetation would have consisted entirely, or nearly so of two of the great divisions of the vegetable kingdom: the ACROGENOUS CRYPTOGAMIA, represented by the herbaceous and arborescent ferns, [the latter reduced to the true *caulopteris*,] the *lepidodendreæ*, a family nearly related to the *lycopodiaceæ*, and some *equisetaceæ*; and the GYMNOSPERMOUS DICOTYLEDONS, comprising the *sigillariæ*, [*sigillaria*, *stigmaria*, *lepidofloyos*,] the *calamitaceæ*, the *coniferæ*, and probably the *asterophylleæ*, [*asterophyllites*, *annularia*, and *sphenophyllum*.

Mr. Brongniart proceeds to describe a plant which closely approaches a family of the gymnospermous dicotyledons still in existence,—the *cycadeæ*, and of the genus *noggerathia*. This plant, at first known to M. de Sternberg, by the impression of a single leaf, from the coal formation of Bohemia, has since been observed in the coal shales of Newcastle, in those of Silesia, in the Permian sandstones of Russia, and many new species of the same genus are in the schists and coal sandstones of France.

He considers, with M. Humboldt, that each stratum of coal is the product of a peculiar vegetation, frequently different from that which precedes and that which follows it,—vegetations which have given rise to the superior and inferior layers of coal; each stratum resulting, in this manner, from a distinct vegetation, is frequently characterized by the predominance of certain impressions of plants, and the miners, in numerous cases, distinguish the different strata, which they remove, by the practical knowledge they possess of the accompanying fossils. Any seam of coal and its overlying rock or slate, should consequently contain the various parts of the living plants at the period of its formation; and by carefully studying the association of these various fossils, which form so many special floras, containing generally but few species, we may hope to be able to reconstruct these anomalous forms of the ancient world.

Distribution of fossil plants.—Notes from the Quarterly Journal of the Geological Society of London, Vol. I., 1845, p. 566, and Vol. II., 1846, p. 83.

The following extract, [with some modifications derived from Mr. Murchisson's paper on the Permian system,] from a memoir by M. Gœppert, of Breslau, well known for his investigations concerning the fossil remains of vegetables, possesses great interest, as offering a general view of the relative distribution of these remains.

Formations.	Families.	Species.
Lower Palæozoic System:		
Grauwacké, silurian, or formations older than the carboniferous series, including the Devonian series, and the oldest coal or culm beds, - - - - -	8	52
Permian system, or Upper Palæozoic:		
Carboniferous limestone, - - - - - -	3	3
True coal measures of Europe and North America, -	18	816
Lower new red sandstone, Permian series, containing, among others, a few species common to the carboniferous era,	4	39

Formations.	Families.	Species.
Magnesian limestone and kupfer schiefer, chiefly marine fucoids, Permian system,	3	19
Gres bigarré, Bunter sandstein,	8	32
Triassic period; or Lower Secondary:		
Muschelkalk,	2	2
Keuper marls, marnes irisées,	8	52
Middle and Upper Secondary:		
Lias,	12	75
Oolitic series,	9	159
Wealden formation,	8	16
Lower cretaceous beds,	15	59
Chalk,	1	3
Lower Tertiary.—Monte Bolca beds,	4	7
Other lower, tertiary,	10	120
Middle and upper tertiary.—Miocene and pliocene,	52	327
Unknown geological position,	4	11
	169	1792

Recapitulation.	Families.	Species.
Older Palæozoic rocks below the coal measures,	11	55
Coal measures,	18	816
Newer Palæozoic or Permian system, above,	15	90
Triassic and secondary formations,	55	366
Tertiary,	66	454
Unknown,	4	11
Fossil plants,	169	1792

Summary of M. Gœppert's numerical distribution of Fossil plants.—The following table presented by Sir R. T. Murchisson at the meeting of the British Association, in 1845, embodies the same facts as are already announced in detail above.

Palæozoic rocks,	52
Carboniferous group,	819
Permian,	58
Triassic,	86
Oolitic,	234
Wealden,	16
Cretaceous,	62
Tertiary,	454
Unknown,	11
Total,	1792

It was further stated, that the number of fossil plants known to M. Adolphe Brongniart, in 1836, was 527. In the new list they amount to 1792! and it is seen that the carboniferous group contained more than half the known species of fossil plants; a remarkable circumstance, when it was considered that the great herbivorous *land* quadrupeds had no ascertained *existence* before the tertiary period.*

For a notice of the flora and fauna of the amber forests of the countries bordering on the Baltic, our readers are referred to p. 528 of this volume, under the head of Prussian Pomerania.

* Report of the British Association, 1845.

MICROSCOPIC OBSERVATIONS ON THE STRUCTURE OF COAL, LIGNITE AND PEAT.

Among other collateral subjects of interest, tending to throw light on the age, the history and the composition of coal, the mode of investigation through the agency of the microscope, is not altogether inappropriate.

Mr. Hutton, of Newcastle, has instituted a series of examinations of the substance of coals, through the aid of the microscope.

Professor Phillips addressed some observations to the British Association, in 1842, on this new test.

In consequence of the facilities afforded for polishing coal, and of examining it by means of transmitted light, some progress has been made in this mode of investigation.

By the process of combustion another method had suggested itself, for making apparent to the eye the vegetable tissues of which certain coal plants were composed. In the ashes of Staffordshire coal,—a variety not strictly bituminous or caking,—Mr. Phillips was impressed with the analogy they presented to the combustion of certain sorts of *peat*, of a laminated texture; and their microscopic examination showed abundant traces of a vegetable character.

In some anthracite ashes furnished by Sir Henry De la Beche, vegetable tissues were also found; and the same fact is also visible in the ashes of the Pennsylvania anthracites.

A paper was read to the Geological Society of London, Jan. 9, 1833, entitled "Observations on Coal," by W. Hutton. The author was led to this subject by pursuing the method of microscopic examination, so successfully employed by Mr. Witham; and from these observations much interesting information has been acquired, respecting the fine, distinct reticulation of the original vegetable texture, still discernible in the various species of coal, and showing the presence, in the Newcastle coals, of cells which are filled with bituminous matter, extremely volatile.

Another system of cells was discovered, different from the others, which he conceived was adapted for containing gas. These supposed gas cells are found empty, and of a circular form, and in groups which communicate with each other; each cavity having, in its centre, a small pellet of carbonaceous matter. The author establishes a clear distinction between these two classes of cells; for the anthracite of South Wales contains the gas cells, but is quite free from those which, in the other coals, are filled with bituminous matter. The anthracite of South Wales affords a free disengagement of inflammable gas when first exposed to the air.*

Additional light is thrown on this subject by a paper of M. Link, of Berlin, "on the origin of coal and lignites, according to microscopic observations."†

The professor remarks that there still prevail two different opinions relative to the origin of coal. The one sustains the view that it is a turf, peat or marsh of the primitive world; the other that it consists of the trunks of forest trees which have been brought together and here buried.

Ordinary peat consists of earthy matter penetrated by the roots or radical fibres of vegetables, with here and there some portions of leaves. This

* Proceedings of Geol. Soc. of Lon. vol. i. 415.
† Annales des Mines, vol. xvii. p. 593. 1840.

earthy part is composed of the cellular tissue of plants, whose structure has been so flattened by pressure, that it is often impossible to recognise them.

A second and better description of peat is sold at Berlin, under the name of *tourbe de linum*, which consists of cellular tissue, compressed in exceedingly thin laminæ.

A third variety, dug in Lower Pomerania, has acquired the appearance of fossil wood; being compact, and its fracture conchoidal and bright; yet still containing parts which resemble the debris of leaves. There remains no trace of ligneous structure. Some portions of this peat become partially transparent when plunged in olive oil; and still more so when they are coated with rectified oil from coal tar.

By observing a similar process with regard to coals, we are enabled to render a great portion of their parts transparent. It has, in this way, been found that the lignite or brown coal of New Granada, and the coals of Newcastle, of Bridgewater, Saint Etienne, and Lower Silesia, present a structure analogous to peat, and particularly to that of the compact tourbe de linum.

In these coals M. Link did not observe a ligneous structure, resembling that of solid wood.

The coals of Upper Silesia have enabled us to make, by means of calcination, a comparison with wood charcoal, particularly with that of birch, pine, and palm—the *bactris spinosa*. Calcination has restored to the cells or vessels all their distinctness, but did not effect any change in the pores or openings.

It would appear, then, that the fibrous coal which covers more or less the compact coal of Beuthen, in Upper Silesia, resembles burnt charcoal, seeing that its compact portion is peaty. All these coals belong to the most ancient formations.

The Muschelkalk coal in Upper Silesia, is turfy, but that of Diester, in the lias, appears to approach to wood.

The coal of the Quadersandstein of Quedlinbourg, exhibits evidently the wood of conifera.

The lignites of Greenland, in which retinasphalt occurs, are peaty in structure, as are those of Meissner, in Hesse.

In those of New Granada, the wood of the palm is discernible by means of the microscope.

In those of numerous positions in Germany can be traced the wood of conifera; while among those lignites which belong to the dicotyledones, but not to the conifera, may be ranked the Surterbrand, the Bersteinholz, the lignite of Meissner, and that of Brohlhale on the Rhine.

M. Göppert, professor at Breslau, has also pursued similar researches, with interesting results;* and has determined with great precision the character of many lignites in Prussia. Among the additional localities of lignites, which contain wood of the family conifera, and genus *pinus*, are those of Siegen in Westphalia; of Friesdorf near Bonn; of Salzhausen in Wetteravia; near Konigs-Bergen-Prusse, and in Hungary.

We cannot conclude this part of our subject without adverting to the investigations of Dr. Mantell therein. We regret that our limited space forbids us to extract more than the following passage from one of his latest publications.

"Although the vegetable origin of all coal will not admit of question, yet evidence of the original structure is not always attainable. The most per-

* Annales des Mines, vol. xviii. p. 448.

fect bituminous coal has undergone a complete liquefaction, and if any portions of organization remain, they appear as if imbedded in a pure bituminous mass. The slaty coal generally preserves traces of cellular or vascular tissue; and the spiral vessels, and the dotted cells, indicating coniferous structure, may readily be detected by the aid of the microscope, in chips or slices. In many examples the cells are filled with an amber-coloured resinous substance: in others the organization is so well preserved, that on the surface exposed by cracking from heat, vascular tissue, spiral vessels, and cells studded with glands may be detected. Even in the white ashes left after the combustion of coal, traces of the spiral vessels are discernible by a high magnifying power. Some beds of coal appear to be wholly composed of minute leaves, or disintegrated foliage; for if a mass be recently extracted from the mine, and split asunder, the exposed surfaces are found covered with delicate pellicles of carbonized leaves and fibres, matted together; and flake after flake may be peeled off through a thickness of many inches, and the same structure be apparent. Rarely are any large trunks or branches observable in the coal; but the appearance is that of an immense deposit of delicate foliage, shed and accumulated in a forest, (as may be observable in existing pine districts,) and consolidated by great pressure, while undergoing that peculiar fermentation by which vegetable matter is changed into a carbonaceous mass."*

Professor J. W. Bailey has communicated an article in the American Journal of Science and the Arts, on some microscopic examinations which he has instituted, of the ashes of anthracite coal. He observed that on the surfaces of partly burned laminæ of coal, vegetable structure could be readily detected, and that often the tissues were presented in a state of unhoped-for preservation.

These specimens, the description of whose beauty and perfection can scarcely be exaggerated, present all the original markings of the vessels with a distinctness which leaves scarcely anything to be wished for.

They may be examined either as opaque objects, in which the silex appears in relief against the black coal, and shows the form and markings of the tubes very finely; or still more satisfactory results may be obtained by melting some inspissated Canada balsam upon a plate of glass, and, while in a melted state, applying it to a surface of the coal upon which the ducts had been previously found to exist. When the balsam has hardened the coal may be taken off, and it will be found that it leaves, fixed upon the balsam, a thin layer of silica, containing perfectly preserved dotted vessels, which, when viewed as transparent objects, are nearly as distinct in their markings as if freshly obtained from a recent plant.

Among other inferences, derived from his early examinations, Professor Bailey draws the following:

1. That almost every layer of coal is composed of vegetable matter, which still retains very distinct traces of the original organic structure, and which, consequently, proves that it could never have been reduced to a homogeneous pulp.

2. That the plants which chiefly contributed to form the mass of the coal were not the ordinary dicotyledonous or monocotyledonous plants, but they more probably belonged to the acotyledons, among which the ferns and lycopodiaceæ present similar vascular bundles.

Mr. A. Brongniart, however, has decided, with Lindley and other inves-

* Mantell's Medals of Creation, vol. i. p. 92.

tigators, to remove the calamites, the sigillaria, stigmara and lepidodendrons from the monocotyledons, and group them with the dicotyledons.

The presence of bitumen, and the consequent swelling and partial fusion of the ordinary bituminous coal, in making these experiments, render it difficult to obtain, from that species of coal, the tissues in the perfection in which they may be found in anthracite.*

Carbonization of Wood.—Dr. Mantell has treated at length on this interesting subject in his "Wonders of Geology." In a more recent work he remarks,—"that the structure and composition of a plant affected its carbonization there can be no doubt; for in the same layer of stone, [in the calciferous grit of Tilgate forest,] the stems resembling palms, *Endogenites*, invariably possess a thick outer crust of coal; while the stems and roots of the *Clathrariæ*,—plants allied to the yucca, or dracæna,—have not a particle of carbonaceous matter, but are surrounded by a reddish brown earthy crust.

The nature of the stratum in which the plants were imbedded, must, of course, have also influenced the bituminous fermentation. Vegetable remains, when interposed between beds of tenacious clay, by which the escape of the gaseous elements, set free by decomposition, was prevented, appear to have been most favourably situated for their conversion into lignite or coal. Experience has shown that although the true coal-measures are only found beneath the saliferous formation [of England,] the production of good combustible coal is not necessarily restricted to any period or series of strata; but may occur wherever the local conditions were favourable to the complete bituminization of beds of vegetable matter. In fact, the productive coal-fields of Buckeburg, in Hanover, are situated in deposits of the Wealden epoch."†

Coniferous Fossil Wood in the newer coal formation of Nova Scotia.—For a knowledge of these fossil trees we are indebted to Mr. Dawson. According to his relation, at a particular level, in the lower part of the newer coal strata, calcareous petrifactions of coniferous wood are very abundant, in some instances appearing to have belonged to extensive rafts of drift-wood. A bed of sandstone, containing one of these petrified rafts, is well exposed on the shore between Cape Malagash and Wallace Harbour, and is there associated with a bed of gypsum, and a thin layer of limestone containing a few marine shells of species found in the lower carboniferous rocks.

In the bed of coniferous wood at Malagash, the structure of many of the trunks has been very perfectly preserved; and slices exhibit, very distinctly, polygonal discs on the walls of the cells, like those of the genus *Araucaria*. On comparing them with others from different parts of Nova Scotia, and New Brunswick, Mr. Dawson found that the species of coniferous trees most abundantly found in the coal formation of Pictou and Cumberland counties have the structure of Araucarian pines. On the weathered ends of trunks of Araucaria, in the sandstones at Pictou and near Wallace, rings of growth are often very apparent. In some instances, the layers of yearly growth having separated in the progress of decay, as is often seen in recent wood, they have left vacant spaces, occupied, in the fossils, by calcareous spar. In a transverse slice the rings of growth can easily be seen by the naked eye. They do not exceed in width those of vigorous individuals of many

* Silliman's Journal, May, 1846.

† Mantell—Wonders of Geology. p. 373, 688. Medals of Creation, 1844. Vol. i. p. 89-90.

recent coniferous species, but their limits are much less distinctly marked than in any coniferæ now growing in this climate.

It is perhaps worthy of notice, that the alteration effected from the original structure of these calcareous fossils, consists merely in the filling up of the cavities of the cells with carbonate of lime, and in the carbonization of their walls. When fragments are exposed to the action of diluted hydrochloric acid, the calcareous matter is removed, and a flexible carbonaceous substance, retaining the form of the fragment, remains. This residual woody matter burns like touchwood, and leaves a very little white ash.

Coniferous wood is not unfrequent in the nodules of iron-stone, included in the great coal-bed at the Albion mines. More rarely they afford fragments with the structure of stigmaria.

Stigmaria. At the extremity of Malagash Point, Mr. Dawson discovered in a bed of shale, a fossil stump of a tree, having connected with it roots with regular scars like *stigmaria.* A portion of one of the main roots, ten inches in length, was seen to be attached to the stump, and other portions appeared in the surrounding clay. The trunk exhibited an external coaly envelope or bark irregularly corrugated: its stony cast showed, indistinctly, alternate smooth and rough vertical stripes, and internally it possessed an eccentric core, probably corresponding with that of the roots, and having large transverse prominences, which appear to have been connected with fibres or bundles of vessels, whose remains extend outward and downward through the outer part of the cast.

Artisia or *Sternbergia.* Fragments of plants of this genus are frequently found in the sandstones of the Pictou coal-field; usually in beds which also contain *calamites.* They are in the state of stony casts, always invested with a thin bark or coating of lignite, whose outer surface is smooth and without transverse wrinkles. Mr. Dawson saw none with any trace of roots, leaves, or fruit, or even of a conical termination: all were cylindrical fragments, and so similar in their markings, that they may have belonged to one species.

Transversely ridged stems, of a character very different from the above, are occasionally found in the carboniferous beds of this province. They are stony casts, having irregular and often large transverse markings, and enclosed in a thick coat of lignite or fossil wood. Transverse sections showed cellular tissue apparently with medullary rays, and much resembling the wood of coniferæ. These last are referred to casts of the pith of trees. Those previously mentioned apparently belonged to a plant having a very large pith and a comparatively thin woody envelope—in short a gigantic rush-like plant, perhaps leafless and nearly cylindrical, like some modern species of *juncus.** In this view Mr. Bunbury fully concurs, and recommends an adherence to the name *Artisia* given to these bodies, rather than that of *Sternbergia,* which name belongs to a genus of recent plants very different from these fossils.†

Coal vegetation of Frostburg in Maryland.—There are some details of the fossil forms at the Frostburg mines, deserving note, in an article in the Quarterly Journal of the Geological Society of London, in May, 1846, by Mr. Bunbury. These beautiful plants are figured and named as

1. *Pecopteris emarginata.* [*Diplazites emarginatus* of Goppert?]

* Dawson on Nova Scotia Coal plants. Quarterly Journ. Geol. Soc. London, May, 1846. p. 132.

† Bunbury, Ibid., p. 138. Also Mr. Dawes, on Sternbergiæ, Ibid., p. 139.

2. *Pecopteris elliptica.*
3. *Danæites asplenioides.* (Goppert.)

With these fossil ferns Mr. Bunbury describes the following less rare plants, which were collected at Frostburg by Mr. Lyell.

4. *Neuropteris cordata*—very abundant, and certainly identical with the English plant.
5. *N*——— gigantea?
6. *Cyclopteris?*
7. *Pecopteris arborescens.*
8. *P*——— *abbreviata.*
9. *P*——— (?)
10. *Lepidodendron tetragonum.*
11. *L*——— *aculeatum.*
12. *L*——— (?) resembling in its markings the *Sigillaria menordi* of Brongniart.
13. *Sigillaria reniformis?*
14. *Stigmaria ficoides.*
15. *Asterophyllites foliosa.*
16. *A*——— *tuberculata?*
17. *A*——— *equisetiformis?*
18. *A*——— undescribed, but said to be found in the "middle coal," near Manchester.
19. *Artisia* ———?
20. *Calamites nodosus.*
21. *C*——— *dubius?*

Mr. Bunbury remarks that the very striking similarity between the coal plants of North America and those of Europe makes it probable that a similar kind of climate also existed in both countries at that era; and whatever conclusions we may arrive at, in relation to the carboniferous period in the one continent seems equally applicable to the other. Nothing, he continues, that has yet been ascertained relative to the coal formations of either continent seems at all inconsistent with the suggestion of Mr. Lyell,* touching the climate of the period in question.

This view is, that the climate was then characterized by excessive moisture; by a mild and steady temperature, and the entire absence of frost; but perhaps not by intense heat. It is admitted, indeed, that our materials for the foundation of this theory are perhaps somewhat scanty; being, chiefly, the general character of luxuriance of the carboniferous vegetation; the great abundance of ferns; and the presence of large leaved monocotyledonus plants of a tropical or sub-tropical aspect: for, with regard to the sigillariæ, stigmariæ, asterophyllites, calamites, &c., their real affinites are, he thinks, too doubtful to allow us to found any arguments on them.

That extreme heat is not necessary to the existence of a very luxuriant and quasi-tropical vegetation, is sufficiently clear from Mr. Darwin's interesting observations on Chiloe and other islands of the southern temperate zone.† Chiloe, situated in the 42d degree of south latitude, enjoying little summer heat, and subject to perpetual rains and mists, is covered, as he states, with forests of extraordinary density, and the luxuriance of the vegetation is such, that it reminded him of Brazil. Large and elegant ferns; parasitical monocotyledonous plants, and arborescent grasses, reaching to the height of

* Travels in North America, vol. i. p. 148.
† Darwin's Journal, 2d edit. p. 242.

thirty or forty feet, are abundant. Indeed, in the southern hemisphere generally, owing to the equable climate produced by the great proportional extent of sea, tropical forms, both of vegetable and animal life, range much farther from the equator than in our hemisphere. It appears very probable that the climate of the northern temperate zone, during the epoch in which the coal measures were formed may have been similar to that now existing in Chiloe and the adjoining parts of South America.

Still, considering that the principal coal-fields of England are situated from 13° to 15° farther north than that of Frostburg, the close resemblance of their vegetation is very striking. The absolute identity of some species is not perhaps so remarkable as the very great general similarity of the whole; for those among the Frostburg plants, which cannot be satisfactorily identified with the British species, are, in every instance, very closely allied to them. We should not find so great a degree of resemblance on comparing the recent floras of two regions separated by so many degrees of latitude, whether in Europe or North America. If we may reason at all as to climate, from the fossil vegetation of a country, we must suppose that the climate varied less rapidly with the latitude than it does at present.

In concluding this valuable paper, the writer suggests, that the plants, of which we now find the remains embedded in the carboniferous strata, may probably be but a very small proportion of those which, at that time, flourished on the earth. If, as seems to be now most generally believed, the coal beds are derived from the vegetation of ancient swamps or lakes, existing in the very localities now occupied by such beds of coal, we could not expect to find in them the remains of other plants than such as grew in those bogs, or lakes, or swampy forests, or immediately around them; together perhaps with some which might be washed into them by occasional inundations. May there not have existed at the same time, in other parts of the world, [nay, perhaps at no very great distance from the carboniferous regions,] great tracts of country, indeed whole continents, in which the local circumstances were unfavorable to the preservation of vegetable remains, and of which, consequently, the flora is wholly lost to us?

I think, therefore, that we ought to proceed with great caution in theorizing with respect to the vegetation and climate of the carboniferous era. I believe that the preponderance of ferns in the flora of the coal measures, together with the other characteristics of the fossil vegetation of that period, affords, to a certain degree, good evidence respecting the climate of those particular regions in which the coal measures occur; but we should not be justified in extending our inferences farther. Those parts of Europe and North America, in which the coal-fields were accumulated, may have existed, at that time, in the state of islands, like those of the present Pacific ocean; but it would be rash to infer, as M. A. Brongniart seems disposed to do, that no extensive continents at that time existed in any part of the globe. If, in all departments of geology, it is necessary to advance with caution, and to avoid dogmatism and rash generalizations, it is more especially necessary in the department of fossil botany, where so much of the evidence we possess is fragmentary and imperfect.*

MISCELLANEOUS NOTES AS TO COAL AND FOSSIL VEGETATION.

In continuation of this subject, we proceed to advert to the results of some observations which have been made of late years by individual naturalists.

* Bunbury on Fossil Ferns. Quarterly Jour. Geol. Soc. No. 6. p. 82.

Were we to incorporate in this work the facts, theories, and speculations which have been discussed at different times on the coal subject, we should occupy at least an entire volume. There are many excellent treatises embracing these topics, which the reader, if seeking more information, may consult to advantage. The few notes we add here are inserted with little regard to classification.

The discovery, in 1839, during the progress of excavating a part of the route of the Manchester and Bolton Railway, within the limits of the Lancashire coal-field, of numerous fossil trees of the family sigillaria, standing in a vertical position, with their roots embedded in a thin coal seam, gave rise at the time to much discussion. Mr. Hawkshaw described these trees in two communications to the Geological Society.* These trunks were wholly enveloped by a coating of friable coal, varying from one-quarter to three-quarters of an inch in thickness. Their internal casts consisted of shale, traversed beneath the place of the bark by irregular longitudinal flutings, less than one-quarter of an inch broad and about two inches apart.

Mr. Bowman communicated a paper on the same subject. He is opposed to the drift theory in accounting for coal beds, because they would have been intermixed with more earthy matter than is now proved to be the case in coal; and because they could not have maintained that singular uniformity of thickness and character throughout so many square miles, and such extensive areas that we find prevails in the coal measures; as an instance of which the author cites the thin seam below the Gannister or Rabbit coal, which extends in a linear direction thirty-five miles. It is much more rational to suppose, that the coal has been formed from plants which grew on the areas now occupied by the seams; that each successive race of vegetation was gradually submerged beneath the level of the water, and was covered up with sediment, which accumulated till it formed another dry surface for the growth of another series of trees and plants, and that these submergences and accumulations took place as many times as there are seams of coal within the confines of each basin.

Mr. Bowman proceeds to the examination of the phenomena presented by the fossil trees discovered in the railroad excavations above referred to by Mr. Hawkshaw. He describes, generally, the markings on the internal casts of the trees. The only indications of scars which he could find, his practised eye recognized to be those of a sigillaria.

From a careful consideration of the phenomena presented by the fossils, the author is convinced that they stand where they originally flourished; that they were not succulent, but dicotyledonous, hard-wooded, forest trees; and that their gigantic roots were manifestly adapted for taking firm hold of the soil; and, in conjunction with the swollen base of the trunks, to support a solid tree of large dimensions, with a spreading top.

With reference to fossil trees in general, and especially to those near Manchester, Mr. Bowman proceeds to show; 1st, that they were solid, hard-wooded, timber trees, in opposition to the common opinion that they were soft or hollow; 2d, that they originally grew and died where they have been found, and consequently were not drifted from distant lands; and 3d, that they became hollow by the decay of their wood from natural causes, similar to those still in operation in tropical countries, and were afterwards filled with inorganic matter, precipitated from water.

The author states his reasons for believing that these were solid timber trees. In soft monocotyledonous trees, their stems never expand laterally,

* Proceedings Geol. Soc. Lon., Vol. III. p. 139; and 269, 1840.

but are as thick when only a few years old, and a foot high, as when they attain the height of sixty or one hundred feet. Their roots, also, instead of being massive and forking, generally present a dense assemblage of straight, succulent fibres, like those of an onion or a hyacinth.

Mr. Bowman then combats the view generally entertained, that fossil stems, with perpendicular furrows, as in the sigillariæ, were succulent or hollow plants. He showed by specimens of recent dicotyledonous wood from New Zealand, that, both upon the bark and on the naked wood, longitudinal ribs and furrows, as regular as those on sigillariæ, were displayed; proving, therefore, that these characters are not incompatible with a dicotyledonous structure. By sliced and polished specimens of the bark of one of these fossil trees, he showed evidence of coniferous structure, proving, also, further, their dicotyledonous character. We note this decision with the more particularity, since M. Brongniart at the same time had asserted that "no wood of dicotyledonous plants, properly speaking, have been found in the coal-fields,"* but has since materially changed his views on that point.

The roots of these trees are fixed in what is now a seam of coal nine inches thick. Mr. Bowman infers that one hundred years must be the minimum of time which would be required for the production of the vegetable matter out of which the nine inches of coal were produced; and he estimates that the thickness of the solid coal is equal to about one-third that of the vegetable matter out of which it was produced.†

An instance very similar to this was detailed by Mr. Witham, in a communication to the Philosophical Magazine, entitled, "On the vegetation of the first period of the world, during the deposit of the transition and coal series." The author illustrates by a diagram the fossil stems of sigillaria, which occur beneath the main seam in the great Newcastle coal-field, at one hundred and fifty yards beneath the surface.

The fossil plants stand erect in the sandstone, their roots being imbedded in the ten inch seam of coal below. "These stems, [as shown in the figure,] are truncated after passing through the sandstone, and are lost in the main coal seam; leaving room to believe that they may have formed part of this combustible mass or bed." The saginariæ, the stigmariæ, and the calamites, he observes, do not appear to have been sufficiently strong to have resisted the force of a current of water, but are placed horizontally.‡

Position occupied by Sigillariæ.—The trunks of these trees are found both in the floor and the roof of coal seams; their position commonly being the upper part of the coal and the lower part of its roof. The sigillariæ are arranged by M. A. Brongniart among the conifera; by Dr. Lindley under the name of caulopteris, and by Count Sternberg as syringodendrons. Some discussion and much new light have arisen, and it seems nearly settled that the numerous tribe of sigillariæ are to be removed altogether from the arborescent ferns to the dicotyledon family. M. Brongniart has been able to take the measurement of one of these stems, which was horizontally extended to the distance of more than forty feet; but has rarely had opportunity to examine their height, their general form, and their mode of termination, on a large scale, in the mines.

In Pennsylvania we have had some favourable opportunities of observing and illustrating the position of enormous trunks in the anthracite mines. The Transactions of the American Philosophical Society contain a memoir

* Histoire des Vegetaux Fossiles.
† Proceedings Geol. Soc. London, Vol. III. p. 270.
‡ Phil. Mag. January, 1830.

on the fossil stems of large trees belonging to the family of sigillaria, which occur both in the roof and floor of a coal seam in Dauphin county.* They consist of several species of these trees, which are displayed in a very interesting manner upon the nearly vertical walls of the vein for several hundred feet in length.

The Floor.—As usual in Pennsylvania, the "bottom slate" consists of indurated clay and shale, more or less laminated. This lamination, it may be observed, is principally due to the flattened sheets of enormous sigillaria. Very few of these compressed trunks are of a less diameter than two feet; many of them are three feet; several are four and four feet and a half wide, and one specimen is at least five feet broad in its flattened diameter. More than a hundred of these are exhibited in the drawing which illustrates the paper referred to. The coal seam had not at the time commenced to be worked; and as its position was approaching to vertical, the gallery of exploration was conducted longitudinally along it, having the floor on the right hand and the roof on the left. Consequently, although several hundred feet in length of walls were exposed on either side, the height denuded was comparatively limited, and afforded little chance for determining the length of the trunks. In no instance was the area of excavation sufficiently extensive to exhibit either extremity of these gigantic stems, notwithstanding that many of them are inclined in such a position as to be exposed for thirty, forty, and fifty feet of their length, without much apparent diminution or tapering upwards, and are perfectly straight.

The Roof.—This is the north or hanging wall of the vein, and consists of coarse siliceous conglomerate of white quartz pebbles. Between it and the coal, and embossed, as it were, upon the surface of the pudding stone, is a very thin coating of clay slate, and an extraordinary assemblage of prostrated trunks of sigillariæ. In diameter they are much smaller than those of the species which form the floor. Instead of being straight like them, these are bent or curved, and some of them appear to be dichotomous, and to possess the characters of *S. elegans.* Such is the scale, as regards height, of these trees, that the extent of cleared space was, as in the floor, inadequate to elucidate their entire developement at any point or in any instance.

One specimen, although laid bare for a length of more than fifty feet, showed no signs of either termination, and looked as if it might have extended thirty or more feet further. Another exhibited sixty-five feet in length, of a flexuous stem, which, apparently, extended at least thirty feet beyond. A third, the most interesting of the group, showed at its base what obscurely seemed to be the root. Near this base the stem was about two feet and a half in diameter. Forty feet up the trunk it measured two feet broad, and continued in about this rate of diminution as far as it was traced. Seventy feet in length of this specimen occur above the level of the floor of the gallery. It was followed, by direction of the author, several feet further, below the floor, and in all was perhaps from eighty to one hundred feet high when growing; but of this, and of the character of that superior termination, we have no present knowledge. It was covered with a bark of anthracite, about half an inch to three quarters or more thick. The interior cast consisted of shale or fire clay.

On applying to this interesting illustration of the ancient flora, Mr. Logan's views as to the universal presence of the stigmariæ in the argillaceous floors of coal seams, and of their absence in the roofs, it was found that in this

* Memoir by Mr. Richard C. Taylor, in Trans. Amer. Phil. Soc., Vol. IX. part II. 1845.

instance, where a surface of seven or eight thousand feet had been recently denuded, stigmariæ were rare. Only two well defined specimens, but of small size, were observed. One of these was seen in the roof above the coal; the other in the floor, below it: but detached leaves were abundant in the lower shale. Six other species of fossil plants were observed in the roof, and seventeen species in the floor.* As usual in the coal seams of this country, a remarkable contrast appears in the condition of the roof and floor. While the appearance of the floor attested the state of tranquillity under which the mud of the ancient surface had accumulated, and the pressure that had flattened those enormous stems of sigillariæ upon which the coal appears to be based, the roof, on the contrary, exhibits the usual indication of violent action of the waters, in the rolled fragments of subjacent rocks, and in the prostration and drifting of gigantic trees, such as we have described above.†

A few of these prostrate trees are very imperfectly represented, as regards scale and details, in the following figure, which has been reduced from a very elaborate drawing.

For further details of fossil vegetation in the formations between the carboniferous series and diluvial accumulations, the reader is referred to the occasional notices under the heads England, France, Austria, Prussia, &c.

USUAL POSITION OF STIGMARIÆ, IN THE FLOORS OF COAL BEDS.

The existence of beds of Stigmaria, in the slate and fire clay which so generally form the strata, upon which coal seams repose, has been pointed out by various persons; in particular by Mr. Logan, who found it to hold good in the coal-fields of both the European and American continents. It is due to earlier observers, however to state that this fact had long since been noticed by Mr. Martin, Dr. McCulloch, and others, including numberless working miners.

In a communication to the British Association by Mr. Binney, in 1842, it appears that the workmen in the principal coal-fields in England, more especially that of Lancashire, regard the presence of stigmaria as a favourable evidence of the vicinity of coal.

All the *floors*, with the exception of one rock floor, in the Lancashire region, from the thin coal seams in the Ardwick limestone, to the two seams in the Millstone Grit, a thickness of near sixteen hundred yards, contain Stigmaria ficoides. All the fifteen floors of the Manchester coal-field contain them; and at least sixty-nine beds in the middle and lower divisions of the Lancashire field.

He adds, [a fact we greatly doubt,] that, in all instances of *true floors*, the stigmaria occurs without any intermixture of other plants.

Sir Henry T. De la Beche corroborated the former portion of this statement as regards Glamorganshire, Somersetshire, Yorkshire, Scotland, and Ireland; and said that he had never seen a *workable* coal bed which did not bear out Mr. Binney's conclusions.

* Proceedings American Philosophical Society, Vol. III. p. 149.
† Trans. Amer. Phil. Soc., Vol. IX. part II. 1845.

Mr. Logan showed that below every regular seam of coal, in South Wales, [and nearly 100 are known to exist there,] is constantly found a bed of clay, so well known to the collier, that he considers it an essential accompaniment of the coal; and only where it ceases, does he give up his expectation of finding coal.

These beds are most strongly marked by containing innumerable specimens of *Stigmaria ficoides*. The stems of this plant, which are usually of considerable length, are said, by Mr. Logan, to lie always parallel to the plane of the bed, and nearer to the top than to the bottom. Portions of the stem of the Stigmaria are found in other parts of the coal measures, but it is only in the underclay that the fibrous processes are attached to the stem, or are associated with it.* The same rule appears to hold good in the coal formation of Nova Scotia, New Brunswick, and the United States.

With regard to the specific plant whose remains have chiefly contributed to form our coal seams, different views have been advocated at times, by naturalists. Without assenting to the doctrine, "that each bed of coal is an ancient Stigmaria bog,† we think that many other plants united to make up the mass, and that the predominant character of these may, in great measure, be inferred from an inspection of the shales, slates, clays, and sandstones, which occur in close contact with the coal itself. In Pennsylvania we have had abundant opportunity of observing coal seams, whose roofs and floors were crowded with sigillaria, and showed but rarely the traces of Stigmaria, or of those forms which are now ascertained to be the roots of the Sigillaria itself. In other cases, the prevailing plants of the shales, on which the coal rested, appeared to be Stigmariæ; while the roof contained chiefly Sigillariæ, and Lycopodiaceæ. On the whole, we were at one time quite inclined to adopt the view of M. Brongniart, that the mass of coal vegetation was more likely to have been derived from Sigillariæ than from Stigmaria. The great number of leaves, he observes, which the Sigillares bore, along their whole length, and which evidently were disarticulated, and had fallen to the then surface of the earth, announce a life of some duration, and a growth which required a considerable lapse of time.‡

One thing appears to be pretty certain,—that the coal-fields exhibit alternate intervals of repose and of energetic action by currents of water—in other words, of a series of epochs of dry land and of inundation. These evidences testify that, after long periods which favoured the quiet growth and accumulation of masses of vegetable matter, they were abruptly terminated; and that this state of things was succeeded by overwhelming currents, which prostrated the forests of Sigillariæ or arborescent ferns; rooted in the ancient surface, and covered them with a debacle derived from older formations, and which we now recognize under the term conglomerates.

During an investigation of the coal beds of Dauphin county, in Pennsylvania, we had ample means of observing, at leisure, these facts: and it was seen, that while the floor of every coal seam consisted of shale, its roof, in the majority of cases, consisted of pudding-stone, whose lower side was impressed and embossed with enormous casts of prostrated Sigillariæ.

Before quitting the subject of coal vegetation, or rather that of the Sigillariæ and Stigmariæ, whose exuviæ are considered mainly to form our coal seams, the progress of discovery in regard to the real nature of those plants,

* Proceedings Geol. Soc. London, Vol. iii. p. 275.
† Proceedings of the American Philosophical Society, May, 1843, p. 182.
‡ Brongniart, Histoire des Vegetaux Fossiles. For details of fossil vegetation in Great Britain, see England.

is too interesting to be omitted here. M. Brongniart, after dissecting their stems, had arrived at the same conclusion as Mr. Bowman, that these fossils had been wrongly classed with monocotyledonous plants, and from a comparison between the fossil and the stems of those recent vegetables which present the closest analogy, M. Brongniart concludes "that the Sigillariæ constituted a peculiar family of coniferous plants, now extinct, which probably belonged to the great division of gymnospermous dicotyledons. In their external forms they somewhat resembled the *Cacteæ* or *Euphorbiæ*; but, by their internal organization, they were more nearly allied to the *Zamiæ* or *Cycadeæ*. The leaves and fruit of these trees are unknown, for no satisfactory connection has yet been established between their stems, and the foliage, and seed-vessels, with which they are collocated."*

But the most important discovery yet announced, relates to the character of the fossil genus *Stigmaria*, which, after all the speculations to which its appearance has given rise, seems to result in determining it to belong to, and, in reality, to form parts of, the Sigillaria itself. Instead of the Stigmariæ being aquatic plants, as it has been customary to consider them, M. Brongniart, author of the elaborate Memoir on the Sigillariæ, "from a careful examination of the internal structure of the Stigmariæ, contended that *they were not aquatic plants, but the roots of Sigillariæ;* the central axis, or cylinder, bearing a close analogy in organization to the stems of those trees."

"This opinion of the eminent French Savant, has been confirmed by the discovery, near Liverpool, in coal strata, of an upright trunk of a Sigillaria, nine feet high, with its roots, eight or nine feet in length, still attached, and extending in their natural position. *These roots are undoubted Stigmariæ of the usual species, S. ficoides; and the radicles, formerly considered leaves, are spread out in all directions, to the extent of several feet.*†

The existence both of Coniferæ and Cycadeæ, which heretofore had been doubted, in the coal measures of the former world, is now established satisfactorily. M. Alex. Von Humboldt assures us that the Coniferæ have not only relationships with the Cupuliferæ and the Betulineæ, by the side of which we encounter them in the brown coal formation, but they are further connected with the Lycopoditæ. The family of the sago-like Cycadeæ approaches the palms in external appearance whilst agreeing essentially with the Coniferæ in the structure of the flowers and fruit. In the coal measures of Nova Scotia, fossil Coniferæ are very abundant, as Mr. Dawson has shown.‡

Since the statement of Mr. Binney, respecting the two fossil trees with marked roots resembling Stigmaria, which were discovered at St. Helens in Lancashire, Mr. Dawson has described numerous corresponding instances in the coal-shales of Nova Scotia, and Mr. Bunbury states that the symmetrical quicuncial arrangement of the scars in the Nova Scotia specimens, the presence of the eccentric axis, and the general appearance of the fossils, leave no doubt that they are referable to the supposed genus *Stigmaria*. Dr. Lindley, who seems to have been the first to hint,§ that Stigmaria might possibly be the root of Sigillaria, compares the dome-like centre and radiating arms of Stigmaria with the roots and base of the stem of *Sig. pachydermata*.‖

Mr. Bunbury, in discussing the progress of his investigation into the cha-

* Medals of Creation, Vol. i. p. 138—140.
† Communication to the British Association, 1843, by Mr. Binney.
‡ Quarterly Jour. Geol. Soc. of London, May, 1846.
§ Penny Cyclopedia, art. Coal plants, 1837.
‖ Fossil Flora, t. 54.

racter of these remarkable extinct forms of vegetable life, observes that the similarity of the vascular tissue of the Sigillariæ to that of ferns is not a sufficient proof of any real affinity to that tribe of plants, since Mr. Brown has ascertained that vessels of a similar structure, constitute the whole of the woody tissue of *Myzodendron*, a genus of parisitical flowering plants, allied to the misletoe, and totally dissimilar to ferns.*

A very satisfactory and characteristic specimen, showing unquestionably that the Stigmaria is the root of the Sigillaria, has lately been brought to light from the Victoria pit at Dunkinfield, in the Manchester coal-field, where, at the depth of 1000 feet, the fire clay, in which the tree was imbedded, underlies the cannel coal. This was first noticed by Mr. M. Dunn, and has since been described by Mr. Binney;† and is now in the collection of the Manchester Geological Society.

The stem of this fossil is unquestionably that of a Sigillaria; exhibiting all the ribs, furrows, and scars of that genus. It is four feet, ten inches in circumference at its base. On the outside is a coating of bright coal, one third of an inch in thickness; very much resembling that found on the *S. pachyderma*. In every respect, Mr. Binney observes, this stem resembles the two trees found in the St. Helen's mine, before alluded to, and also to the Dixon Fold trees, described by the late Mr. Bowman.‡

The roots gradually assume all the true characters of Stigmaria, with depressed areolæ, &c., and have been traced for fifteen feet; at which distance they average about six inches across, without any signs of terminating.

Mr. Binney concludes his description of these fossil trees with the remark, that it seems evident that Sigillaria was a plant of an aquatic nature, from the position of the St. Helen's trees, which were found on the identical spots where they grew, imbedded in a fine silty clay, sixteen yards above and sixteen yards below, or midway between two seams of coal.

Sigillariæ and Stigmariæ of the American Coal-fields.—In confirmation of the last named English observers, and in addition to those discoveries previously cited, by several geologists in British America and the United States, we have more recently had the evidence of many similar fossil trees in the Sydney coal-field of Cape Breton, described by Mr. Brown.§

The sea cliffs on the north-west shore of Sydney Harbour, present an interesting section of the coal measures, and unusual facilities for observation. Fossil trees are seen therein at various levels, but abundantly in a stratum of arenaceous shale, lying almost immediately under the main coal, where, within a space of eighty feet, eight erect trunks are seen, with their roots and rootlets attached to them. They all occur at right angles to the planes of stratification, and belong to the same species; being evidently young individuals, which range from two to sixteen inches in diameter only. Mr. Brown's paper is illustrated by drawings of these fossils as they appeared in their native sites. Their bark, converted into bright coal, is very thin; it is marked with longitudinal furrows and ridges.

The roots, which are true Stigmariæ, with *rootlets* or [as they generally have been called] *leaves*, spreading out in every direction, are about three inches in diameter at their junction with the stem. Two of these roots, in the plant figured, have been followed to their terminations, where they gradually thinned out to a mere line in one direction, being about three quar-

* Mr. Bunbury on Stigmariæ, Quarterly Journal Geol. Soc. of London, Vol. ii. p. 136.
† Quarterly Journal of the Geological Society of London, Vol. ii. p. 390.
‡ Transactions of the Manchester Geological Society, Vol. i. p. 112.
§ Quarterly Journal Geol. Soc. London, Vol. ii. p. 393.

ters of an inch in width. They are generally thickly studded with tubercles, presenting an imperfect spiral arrangement, and are covered with a thin bark, or coating, of carbonaceous matter.

The leaves or rootlets, varying in length from three to twelve inches, are flattened; being much broader near their junction with the roots than at any other point.

All these circumstances seem sufficient to prove that Stigmariæ and their leaves are, in reality, the roots and rootlets of a class of trees, allied probably to the Sigillariæ.

On the Fossil Vegetation of America—by J. E. Teschemacher—with illustrations in wood.*

An important source of information is presented by the vegetable remains existing in the coal itself; leaving out of consideration those in the shaly roofs and clayey floors of the mines. The Pennsylvania anthracites offer many specimens of these. What is termed charcoal is commonly found in seams and crevices in the coal; and in most of this, the vegetable tissues, although carbonized, are in perfect preservation.

Mr. T. proceeds to describe a series of coal plants from Carbondale, in Pennsylvania.

He considers *Sigillariæ* as the stems of *Filices*, observing, "It seems to me almost impossible not to be convinced, by the arguments of Brongniart, that these are the stems of the arborescent ferns, whose leaves are scattered in such profusion around them,—although I am aware that both Göppert and Lindley have withheld their assent to this opinion."

The present is probably the most fitting place to allude to a late valuable contribution to our knowledge of the internal structure of fossil plants, in the work of A. J. Corda, entitled "Contributions to a Flora of the Ancient World."† The following notices, derived chiefly from the Journal of the Geological Society of London, are selected with reference to their bearing on the families of coal plants which we have been considering.

Sigillariæ. The author differs from M. A. Brongniart, respecting the affinities of these plants. He believes that the Sigillariæ were succulent Dicotyledons, closely allied to the recent Euphorbiæ.

The leaves of the Sigillariæ have been hitherto unknown, except in the single instance of *S. lepidodendrifolia*, as figured and described by A. Brongniart.

M. Corda has discovered the leaves of *S. rhytidolepis*, which bear a strong resemblance to those of *S. lepidodendrifolia*, and other species; and it is very probable that some of the so-called *Lepidophylla*, which occur very frequently in a detached state, in the coal formations, may be the leaves of Sigillariæ.

The author is of opinion, in agreement with a M. A. Brongniart, that the temperature which prevailed during the period of the coal formation, was very high.‡

It may be useful to geologists to mention also that the work of M. Corda contains tables, which show the number of fossil plants in each formation of the earth, and the number of fossil ferns in proportion to that of other plants; an enumeration of living ferns, distributed by tribes, and according to the zones of temperature in which they occur; also a list of fossil ferns by tribes, showing the proportion of the fossil to the recent species, known

* American Journal of Science and Arts, Jan. 1847.
† Beiträge zur Flora der Vorwelt. Prague, 1845.
‡ Quarterly Journal of the Geol. Soc. of London, vol. ii. p. 219.

of each tribe: and a table enumerating the arborescent ferns, known in a recent and in a fossil state, and also the *Marattiaceæ*, known in each of these states, comparing them with the total number of ferns, recent and fossil.

As to the class of Plants which form the Coal Vegetation.—According to M. Burat, there are about three hundred species of coal plants recognized; of which five-sixths belong to the cryptogamous vasculaires [vascular cryptogami?] that is to say, to the ferns, the calamites and neighbouring families. These vegetables form one-sixth of the actual existing flora.

The coal vegetation, which is remarkable for the predominance of the cotyledonous species, is most analogous to that of the existing epoch where developed in certain low and humid islands in the warmest latitudes. The researches of M. A. Brongniart in this vegetation, showing that it resembles that of our equatorial regions in the abundance of equisetaceæ, palms and arborescent ferns, leaves no doubt respecting the origin of the coal, and we can even find direct proofs in the mechanical analysis of certain varieties.

Coal Shales.—We believe it is now generally admitted that nearly every coal seam in the world is imbedded upon an argillaceous stratum, more or less indurated, in every gradation, between soft fire-clay and compact slate. These argillaceous beds are characterized by the abundant traces of the fossil vegetable, Stigmaria, which rule is sufficiently exact, in most instances, to enable the miner, when engaged in exploring for coal beds, to distinguish, with the aid of some other obvious characters, between the shales which form the roof and the floor of those veins, or what is commonly termed their "top slates" and "bottom slates."

In some of the coal-fields of Europe, the "top slates" or roofs are as much characterized by courses of nodular iron ore, as the fine clay floors are distinguished by their fossil vegetable traces. In the United States, the clay iron ore, although occasionally present, does not seem so abundant as in Europe.

The carboniferous shales contain but little bituminous matter, in America; and generally speaking, we believe, not in England or Wales. In Scotland we are assured the shale is often so bituminous as to be used for fuel; as at Pitfirrane in Fifeshire, and other places; and it gradually passes into pure coal.*

The upper shales or "top slates" are seldom so regular as the bottom slate. They are commonly thin interposing seams between the coal and the overlying sandstone. In Pennsylvania it is of very common occurrence that beds of coarse gritstone and conglomerate are in immediate contact with the underlying coals; showing that the period of quiet which marked the deposit of mud and clay in which the stigmariæ are imbedded, and that of the tranquil accumulation of vegetable matter which forms the purest coal veins, was abruptly succeeded by a period in which the waters were in a state of tumultuous agitation;—when the trees on the then existing surface were prostrated and buried beneath thick beds of pebbles and gravelly debris.

Origin of Coal.—In relation to this subject, M. Burat has noticed that, as a great number of varieties of coal contain much more ashes than they had in the vegetables from which they were formed; as, in other cases, the ashes are not of the same nature as the vegetable ashes; as, moreover, in a great number of instances, we find very small lines of schist intercalated in

* Nicols' Guide to the Geology of Scotland, p. 64.

the coal; as even selected portions always furnish a considerable proportion, these extraneous matters may have preserved some historical facts in regard to the formation of coal.

On proceeding to the mechanical analysis of these coals, we perceive that they are formed of thin and superposed lamina, which are composed sometimes of pure, specular coal, yielding scarcely two per cent. of ashes, and sometimes a dull schistose coal, which contains twenty or twenty-five per cent.

The results of these alternations of layers is a diversified structure, in the direction of the stratification, and a series of layers which present frequent traces of vegetable tissue. This analysis demonstrates that the coal is heterogeneous, and is composed of superposed alternations, the one consisting of pure particles which are the result of vegetable decomposition, the other of earthy parts, produced by the action of water, more or less charged with argillaceous matter. The vegetables of which the coal is composed, both M. Brongniart and M. Burat conceive belong chiefly to the small species of genus calamite; in that respect differing from the larger plants, whose debris is found in the slates and sandstones.

Therefore, from these data, we may conclude that these little alternating bands represent a production and a periodical destruction, like those which might result from the seasons of the year. The brilliant or specular laminæ are the decomposed vegetables of this period; the dull or earthy layers represent a portion of this decomposition mixed with impurities such as may be attributed to the invasion by waters holding argil in suspension, and whose periodical return has been one of the causes of decomposition. To the influence of these immersions must be attributed the effects of erosive currents, which have brought together, at certain points, sometimes thick zones of specular coal, and sometimes beds wherein carbonaceous schist or clay predominates.

Thus, then, the coal-fields may have been produced, in great measure, by the growth, on the spot, of small vegetables, in the manner of peat or turbaries; whilst the larger vegetables may have been drifted from distant and elevated points, when the oscillations of the surface produced the interruption or the renewal of this generative action, in placing the coal surface above or below the level of the sedimentary waters.

This hypothesis explains, not only the formation of the thin and multifold beds, in the basins of the north of Europe, for instance, but they also agree with the generation of the thick and limited basins of the south, and of the great accumulations, like those of Montchanin.

The distinctness of the planes of separation demonstrate that the two principal generators were not susceptible of being confounded; in other words, the deposits of sand and clay were effectuated in the water, whilst the coal, on the contrary, has been produced above these waters. Coal, then, is not, properly speaking, a sedimentary deposit, produced by the transportation of vegetables, or by floating rafts, as has sometimes been supposed; and yet its production has taken place very near to the surface of the water, since it has had frequent penetrations of the two generating influences, which thus accumulated, side by side, products so different.

These views of the origin of coal ought evidently to be extended to all the series of fossil combustibles, which represent the vegetable accumulations of various geognostic periods. The anthracites of the transition formations owe their dry and meagre nature only to the difference in the mode of decomposition, determined by the special conditions of the surface of the

globe at that early epoch. It is to be remarked, that if our theoretical ideas of the formation of the globe induce us to attribute this difference to the phenomena of temperature and pressure, which appear to have affected the rocks of the anthraxiferous epoch, this opinion is completely confirmed by the anthracitous state of the combustibles, subsequent to the coal period, which we encounter in the metamorphic formations. We cannot, in fact, doubt that, in the second case, the phenomena of heat and pressure are the modifying causes of beds which originally consisted of coal or lignite.

The tertiary LIGNITES have generally preserved their ligneous tissue so fully, that we can recognize, in many of the fragments, the nature of the constituent wood. The fir, the alder, the beech, and the oak, form the most frequent debris of the lignites of the Alps, and they thus denote a complete change in the vegetation of the earth since the coal period. They are the true fossil forests, which likewise differ from the coal beds by a more circumscribed accumulation, and by a less complete stratification.

In certain exceptional cases, the lignites have a compact structure, almost comparable to that of coal. They then constitute what is called common *jet*. This is the ordinary character of the lignites in the environs of Marseilles; which give rise to an annual production of more than a hundred thousand tons. These lignites form seven perfectly regular and stratified beds, within the tertiary basin, at Fuveau, Crest, Auriol, &c.; the thickness of each of which beds [from one to three feet,] preserves such constancy that it may be recognized by this character alone, in the divers parts of the basin. These beds are comprised between calcareous strata; they are subject to the numerous movements, inclinations, folds, faults, and upheavings which have disturbed the various portions of the tertiary basin.

Among these accidents, there is one which is peculiar to the lignites, and which is known under the denomination of *mouillères*. These consist of portions of beds where the lignite is so fissured and decomposed that it has become very permeable to water. The workings encounter the double difficulty of abundant infiltration, and a production of no value. In their normal state these lignites have much the appearance of coal, but they have not its quality. Nevertheless, in certain positions, in Tuscany, for instance, we find some small beds of a lignite sufficiently perfect to furnish a coke, on distillation.

The general character of lignite is such, that it cannot be considered as possessing a regularity comparable to the coal beds.

Portland Oolite Beds—Contain Zamia, fragments of which are found in the lower calcareous bed of the group—or perhaps in the inferior portion of the cretaceous series. These plants are accompanied by paladinæ or helices, which consequently indicate the passage of fresh water in the seas of this epoch, where are seen the remains of large coniferæ, rooted in the soil, analogous to the *Araucariæ*, now strangers to the present climate of England. But in the midst of these coniferæ we find plants which have a resemblance to the *Cycas* and the *Zamias* of the tropical climates, and also the animal relics which approach to those of the same zone. The dirt bed of Portland, which incloses trees still in place, attests the existence of a vegetable soil, of earth almost dry, which rests upon the marine deposits. This bed has since been re-covered by very powerful beds of fresh-water limestone, and then passes under the green sand which follows the chalk.

The Wealden group—incloses various vegetable debris—some of which resemble that of the Portland beds—and we meet with, in place, and in a

siliceous state, the trunks of Cycadeas; *Mantellia Nidiformis*. With these occur various species of coniferæ, besides the fragments of equisetaceæ and forms of a peculiar species.

Trias, or the *Grès Bigarré*, or copper group. This great formation, which in France has received the name of Trias, because it incloses three principal parts, is composed of deposits of sandstone and marls, of varied colours, which have given to the sandstone the name of Grès Bigarré, [red and white] and to the marls, that of *Marnes Iriseés*. The two latter in England are known under the name of the *upper new red sandstone and red marl*.

In this group vegetation has undergone great modifications. The ferns and the gigantic equisetaceæ have considerably diminished; while the coniferæ, on the contrary, have become more numerous: plants, analogous to the Zamia, and perhaps to the Cycas, formed at that time an important portion of the flora of Europe; a prelude to the immense development which they made in the succeeding epoch—"*l'epoque jurassique*," or lias.

Vegetable debris and combustibles of the *Molasse*.* This tertiary formation occurs above the *Calcaire Grossier*, in the environs of Paris.

The Molasse is very rich in combustible; it encloses the lignites of Languedoc; of Switzerland; the most part of those in Germany, as well as those of Cologne. All the lignites appear to have been principally formed by the *coniferæ*, of which we are able to recognize the tissue, either in the mass of combustible or in the wood which is disseminated in the midst of the various deposits.

It is known, however, that in this formation there are also many dicotyledonous plants, the wood of which is found disseminated here and there; sometimes in a silicified state, clearly exhibiting the tissue peculiar to this class of vegetables, and characterized, above all, by the presence of large longitudinal vessels.

Leaves also exist; often abundantly, even in the clays which accompany the lignites, and in these can be recognized distinctly the characters which the dicotyledones present. Among them are those of the walnut, the maple, elm, birch, &c.

There exist even fruits, which often cannot be distinguished from those which we find at the present day in our climate.

Finally, there are found in this formation the remains of monocotyledonous plants. This wood presents all the structure of the palms; that is to say, an assemblage of ligneous bundles, disposed longitudinally, without regularity, in the middle of a cellular tissue, as in *Palmacites Lamanonis*.

CUPRIFEROUS LIGNITES.

Vegetable remains under this form present themselves in various geological positions and circumstances, which will be noticed in the progress of this work.

In the provinces of *New Brunswick* and *Nova Scotia* they occur in the regular coal measures. Mr. Henwood has mentioned this interesting fact—that lignites, consisting of ferns and other coal plants occur impregnated with rich vitreous copper ore and coated with green carbonate of copper, on the Nipisiguit, near Bathurst in New Brunswick.† These vegetable remains are, according to Mr. Logan, partly converted into coal, and partly replaced by gray sulphuret of copper. The same occurs in the neighbourhood of Pictou in Nova Scotia, in considerable quantities, and also within the limits

* Cours Elémentaire d'Histoire Naturelle, par M. F. S. Beudant.

† Mr. Henwood in Trans. Royal Geol. Soc. of Cornwall, 1840.

of the same coal-field at the Joggins, on the Bay of Fundy. On the Nipisiguit it has even been attempted to work the deposit as a copper mine; but, on account of the irregular distribution of the organic remains, the operations became uncertain and led to the abandonment of the work. This bed is from two to four feet in thickness.*

In *Pennsylvania*, United States, beds of vegetable stems, impregnated with vitreous copper and green carbonate, occur in the shale or argillaceous beds at the base of the Devonian or old Red Sandstone series. In two or three instances, within our own observation, these were commenced to be worked as copper mines, but the quantity of ore was found insufficient for productive operations. The mineral occurs in the form of rich gray sulphuret of copper. So far as our remarks have extended, it is only the terrestrial and not the marine vegetation of this formation that is cupriferous.

In the *State of New York*, cupriferous lignites occur in about the same geological position, in the Catskill mountain series. They consist, like the preceding, of vegetable casts, replaced by gray sulphuret and carbonates of copper.†

Professor Del Rio mentions certain beds of this character with which he had become acquainted.

In *Russia*, in the carboniferous beds which are considered by Mr. Murchisson to be of the same age as the Zechstein of Germany and the magnesian limestone of England. The flora is peculiar to it; and the fossil stems and leaves of plants are very general indications of copper ore, which, in the form of gray oxide and green carbonate, is disseminated through or arranged around them.

The *Kupper Schiefer of Germany* represents this metalliferous deposit on a smaller scale.‡

In the *Tyrol*, in the upper tertiary coal beds of the valley of the Inn—cupreous vegetable fossils occur.§

Thuringia is remarkable for a cupriferous schist, with lignites and fossil fishes.

In the *Spanish Pyrenees*, Mr. Logan examined, within the coal measures, a bed which presented a combination of coal and gray sulphuret of copper, in the form of vegetable casts. These occupied an eighteen inch seam, cropping out regularly and extensively. It was then worked as a copper mine, and promised a profitable return.||

In *Ireland*, in a bog on the east side of Glendore Harbour, the peat was found to be highly impregnated with copper, which was extracted from the burnt ashes.¶

In *Scotland* and *England*, some of the beds of the old red sandstone have a green tinge, and the more argillaceous beds are mottled with red and green. The former hue arises from the oxide of iron, the different tints depending upon the amount of iron in the beds and on its state of oxidation, while the green colour is ascribed to the presence of copper. Whether vegetable casts occur in these beds as in the United States, we have not learned.

TURBARIES, PEAT-BOGS—TOURBIERES, PEAT-MOSSES.

In various portions of this work, under the topographical arrangement which we have adopted, will be found copious details in relation to this

* Report of the Geological Survey of Canada, 1 May, 1845, p. 63.
† Mather's Fourth Report of New York Geology, p. 229.
‡ Proceedings Geol. Soc. of London, vol. iii., p. 751. § Ibid, vol. i.
|| Logan's Report on the Geological Survey of Canada, 1 May, 1845, p. 64.
¶ Jameson's Mineralogy of the Scottish Isles.

useful combustible; the most recent deposit, if we may so employ the term, but nevertheless by no means the least valuable, of the class of fuels which we have to bring under consideration. It will be unnecessary, therefore, to recapitulate them in this place. Respecting the origin of these modern deposits, which bear some resemblance to coal-fields, it is not uninteresting to trace the process of their accumulation or development.

Turbaries, formed in depressions of the soil, where the shallow waters constantly remain, are found dispersed, here and there, on the surface of plateaux more or less elevated, or upon low plains, and often follow the direction of the valleys, whose hollows they fill. These deposits sometimes present several beds of the combustible, separated from each other by argillaceous, sandy, or calcareous matters; now and then filled with the remains of aquatic or terrestrial mollusques which still live in the country.*

They only originate under peculiar circumstances. They are formed neither in running waters, nor in deep lakes, nor in the transient pools of water which occasionally dry up. It is only produced in places where the waters stagnate, or are slowly renewed, and have an inconsiderable depth.

The production of peat is principally due to the accumulation of cellular vegetables, which are constantly submerged and which multiply with rapidity; such as the *sphagnæ*, *confervæ*, &c. To these are added a great number of terrestrial vegetables, which are brought thither by streams, either in their ordinary condition, or during inundations. Frequently, also, we find large trees, which are buried more or less deeply in the moss, and particularly in the lower parts, where they are accumulated upon the sands and clays which form the base. Sometimes these trees appear to be standing, but most frequently they seem to have been broken off on the spot, and thrown down near their roots, which are seen fixed at the bottom of the turbary. In certain cases they are extremely numerous, and seem to indicate entire forests which have been buried in the same spot where they grew, before the formation of the peat bog. All these plants conform to the existing vegetation. They consist of resinous trees, of oaks, birch, sometimes the ash, elms, &c. The first are generally the best preserved; they have, especially, maintained all their solidity, and are only blackened: the others, on the contrary, are to a certain extent, reduced to a rotten earth, which falls into powder on drying. We also frequently find the remains of mammifera in these peat-bogs, and these commonly belong to animals of the existing epoch. These are the bones of oxen, the horns of stags and roe-bucks, the tusks of wild boars, &c.

Turbaries or peat-bogs are abundant on the surface of the globe, in the cold and temperate regions, and are distributed in basins, like the coal-fields, more or less expanded, at all elevations, and occupy the various depressions of its surface. They are even on the summits of mountains, as in the Alps; on elevated plateaux, as in the centre of France; or in the lowest plains, where they cover sometimes immense spaces, as in Silesia, Prussia, Hanover, Westphalia, and Holland. Details will be found under each of these local heads in this volume.

If the majority of turbaries are formed on the main land, and entirely by fresh water vegetables, there are others which appear to have been deposited in the marshes which communicate with the sea; as the greater part of those in Holland. Some of these deposits consist of wrack or drifted seaweed and marine plants, such as we still see upon the flat and sandy shores of the ocean, and particularly upon those of Friezeland and Jutland.

* Beudant, Geologié, p. 98.

It is remarked by M. Beudant, that the hypothesis which assimilates the coal beds to the turbaries is fortified by the different characters which they present. These are, on one side, the numerous debris of cellular cryptogami, which microscopic examination discovers in such combustibles as turf, the trees standing rooted in the middle of the deposits, and the remarkable preservation of the leaves in the schists; on the other, the disposition in basins, more or less extended, and isolated from each other, surrounded by the earlier rocks;—all circumstances which seem to indicate pools of water, and marshy places formed in the depressions of an open country. We frequently also observe that a certain number of small independent deposits form portions of a more extended basin; of a species of lake, filled with arenaceous contemporaneous matters, at the surface of which will be formed so many separate heaps of combustible: they are, as it were, inclosed in a species of ancient valleys, along whose length they are dispersed.

Certain desposits of lignite are evidently formed in the same manner as coal, of which they present the same characters, "*allures;*" but there are others which exhibit masses of wood, thrown pell-mell, more or less bituminized, preserving their tissue, buried by chance, in the middle of the sedimentary deposits; reminding us of those which are drifted by great rivers, which deposit them in the lakes, or which are transported to the middle of the seas.*

In France, where every description of fuel is valuable, the working of the turf pits is carefully attended to, and, in great measure, but not entirely, is under the surveillance of government officers. At the proper place we shall quote the annual returns of these officers to the minister of the interior; when it will be seen that the value of the turf is very far from inconsiderable, and approaches even to the value of the coal itself.

The usual process of cutting this turf is as follows. When the peat is above the level of the adjacent waters, as it is a substance always soft and easy to be cut, it is worked by digging small trenches with a succession of steps or grades of elevation, whose height is that of the spade which cuts them, say about one foot. These steps are separated by a breadth of at least three feet, upon which the workmen walk in file, one after the other, taking off, from each side, a series of prisms of about five inches in thickness. These prisms are immediately collected by the porters, *chargeurs*, who follow the cutters with wheelbarrows.

To raise thus a line of prisms from the whole length of a step or bench, is what is called raising a *point* of turf. The labourers can follow on the same step, *gradin*, in working out the successive *points*.

The extracted turf is carried to the drying floors, in the driest and best ventilated places in the vicinity. At first they deposit these prisms of turf flat on the ground, like bricks, and superposed to a trifling height; then, when they have acquired sufficient consistence, they are piled in walls open to the day, about three feet in height, which form a series of broken lines, in such a manner as to present solidity, and, at the same time, to permit the air to circulate without the wind being able to upset them. It is only after complete desiccation, that they are able to pile the peat in the form of stacks, which are then thatched with stubble, to prevent deterioration; for if it has not been well dried, it will heat, and if, on the contrary, it attain a point of desiccation too advanced, it will be crushed so as to occasion much waste.

If the peat-bog be again covered by water, there will be a renewal of its original condition, but very often the workmen are compelled to work be-

* Beudant, Cours élémentaire d'histoire naturelle, p. 115.

neath the surface of the water, after having lowered its level by every possible means.

The consistence of the turf being very slight when first withdrawn from the water, they employ, in extracting it, implements called *louchets*, whose forms are designed to increase the adhesion of the cutting surfaces to the matter cut. The common louchet is a spade with a lateral wing or flange, making an angle with the surface. With a single cut, this tool can detach a prism of turf whose angular surface facilitates the raising. Other louchets carry a fork, with a spring, which is designed to press the prism of peat against the surface of the blade.

In Bavaria, towards the sources of the Mein, the peat-beds are from six to twelve feet thick. The turf is mossy, and contains numerous buried and decomposed trees; among whose remains we are still able to recognize many existing species.*

It will be seen from the numerous facts which we have accumulated in the following pages, and especially from the illustrations on the map of the terrestrial globe which we have annexed, how far they sustain a theory which supposes a zone or belt of coal vegetation around the earth.†

A difficulty here presents itself at the outset, by reason of the comprising under one common denomination of coal, deposits of very different ages. It is true that carboniferous formations appear, at intervals, in almost every quarter of the habitable globe, but the more recently produced coals and lignites have no apparent conformity with the arrangement of the true coal beds.

The greater part of the basins of true coal is decidedly limited to the space between the Tropic of Cancer and the Arctic circle. But the coals of later epochs,—those from the oolites up to the tertiary periods, obey no such law of arrangement. They are found in both hemispheres, extending almost from pole to pole, and crossing the range of the old coal formations almost at right angles.

Thus we have detached coal deposits of later origin than those of true coal, and we have occasional accumulations of tertiary lignite or brown coal southward as low as S. lat. 50°, and as high northward as N. lat. 70°, embracing the extreme accessible points upon our globe.

There is an immense range, although with many interruptions, extending in a north-west direction, over nearly half the circumference of the globe, from New Zealand, Australia, Borneo, Siam, Ava, and Burmah, and across Hindostan, and by the Caspian and Black Seas, across Europe, even to the Baltic.

We are by no means certain, in many cases, of the relative ages of what passes under the ordinary denomination of coal, and besides many extensive deposits have received no scientific examination. But we know, for instance, that brown coal exists as far to the southward as Kerguelen's Land, and at each extremity of North and South America and Asia, and of Africa, at the Cape of Good Hope, and Algeria; throughout Europe, and on both shores of Greenland. Lignite, apparently of the same age, stretches, at intervals, through 125 degrees of latitude, and along both the American continents, from the Straits of Magellan to the Arctic Ocean.

We need not repeat here that these newer coals are at once distinguished by their inferior calorific power; while the naturalist recognizes them by

* Burat, Géologie appliquée, p. 380.
† An Essay on Organic Remains, by Thomas Gilpin, Philadelphia, 1843.

their geological associations, and by the peculiar animal and vegetable races which characterize the epoch of their formation.

ORGANIC REMAINS IN THE CARBONIFEROUS PERIOD.

Insects.—Professor Agassiz remarks that, "with regard to insects, their existence has been already ascertained in the coal formation, which, in my opinion, is much more intimately connected with the palæozoic than with the secondary formations, by the whole of its organic characters."

Entomostraca, of small size, abound in certain coal formations, and they are found after that period in a multitude of deposits.

Trilabites, which are unquestionably the most ancient type of the class crustacea, appear under the strangest and most varied forms, from their first occurrence in the most ancient palæozoic formations. This type, however, does not go beyond the period of the coal formation, when it is replaced by gigantic Entomostraca, which are in some degree the precursors of the *Macruri*.

Fishes.—"When I commenced the publication of my researches on fossil fishes, I was acquainted with no species more ancient than that of the coal formation, and even with a very small number of these. Now, not only is the list of species and even of genera proper to these formations considerably increased, but the more ancient deposits are daily increasing more and more the number of types to add to our catalogues. The strata of the Devonian system, and those of the Silurian system, have in their turn furnished a contingent, which continually goes on increasing."

We cannot here resist the desire to pursue our quotations from the same Professor's Fossil Fauna of the precursor of the great carboniferous formation, the old red sandstone, which also contains the most ancient deposits of coal that are yet known. "The ichthyological fauna of the old red sandstone appears in such extraordinary and fantastical forms, that the most trifling remains of the beings which lived at that epoch, cannot fail to interest the attention of the naturalist. In no other formation do we find an assemblage of fishes, deviating so strikingly from all that we are acquainted with in our own days. The study of no other fauna requires so many years before we become sufficiently familiarized with its types to venture to classify them, and fix their relations to those of other creations.

Comparisons with the remains of anterior formations would have been impossible; because it is in the old red sandstone that we meet, for the first time, with a complete ichthyological fauna. The Silurian formation, it is true, contains some remains of fishes; but hitherto they have been so rare, and the number of species so limited, that it may be safely affirmed that it is only with the Devonian formation that fishes have really acquired some importance among other fossils; or, at least, that the part they performed in nature becomes appreciable."

"What first strikes one, on studying the ancient deposits is, that fishes are the only representatives of the branch vertebrata which exist in the old red sandstone, or even in the coal formation; in so much that we have a good right to call the epoch when these formations were deposited, *the reign of fishes.*

The consideration that the fishes of the old red sandstone really represent the embryonic age of the reign of fishes, has even been with me a powerful motive to undertake the examination of these ancient animal remains, as my first *monograph*, forming a continuation of my *researches;* since it was

here there existed evident facts to prove the truth of this great law of the development of all living beings."

In concluding the introductory article, from whence these few brief but comprehensive passages have been selected, M. Agassiz remarks, that viewing this assemblage of fossil fishes of the old red sandstone, as a simple group of divers, but contemporary species, and apart from all systematic considerations, we are struck with the great diversity which the species really present. "Who would have expected that we should ever find, in spaces so limited as those which have hitherto been explored, above a hundred species of fossil fishes, in the Devonian system alone; that is to say, in a stage of our formations which was believed a few years ago to be confined to the British Islands, and to which, in consequence, only a local value was assigned; and yet, all other things remaining equal, the ichthyological fauna which this formation contains, is as considerable as that which inhabits the coast of Europe; and even although the species of the old red sandstone do not belong to so great a number of families as the living species, they are not less varied in their forms and general aspect, nor less curious in their external characters and organization, nor less different from each other in size, and the degree of locomotive power with which they were doubtless endowed."*

Foot-marks discovered in the coal-measures of Pennsylvania.—In Vol. II. of the proceedings of the Academy of Natural Sciences of Philadelphia, 30th of December, 1845, is an account of fossil foot prints in the sandstone of the coal measures of Westmoreland county, Pennsylvania, by Dr. A. T. King. Those particularly described are reptilian foot-marks, and occur about three miles from Greensburg, and others at Derry, twenty-seven miles from the same town, which seem chiefly to have been made by *ruminant mammals.*

These sites have subsequently been visited by Mr. Lyell, and form the subject of a preliminary article, in the Quarterly Journal of the Geological Society of London.†

The stone on which the Greensburg impressions occur, is a sandstone which rises up from beneath the well-known and widely extended main or Pittsburg ten feet coal seam, whose outcrop is worked in this neighbourhood. The slabs of sandstone are separated by layers of a fine unctuous clay, such as would be admirably fitted to receive the most delicate and faithful impressions of the feet of animals treading upon it.

Twenty-two of these Cheirotherian impressions were discovered by Dr. King, on the under sides of the sandstone slabs, standing out in relief. They occur in pairs; each pair consisting of a hind and fore foot. There are two rows of these tracks which are parallel, or have been formed the one by the right fore and hind feet, the other by the left; the toes turning one set to the right, and the others to the left; and the distances between the successive footsteps being about the same throughout.

Mr. Lyell concurs with Dr. King as to the authenticity of these footmarks, and conceives that an important truth has been brought to light, through the exertions of the latter gentleman;—that the land on which forests of Sigillaria and Lepidodendron grew, gave support also to large air-breathing quadrupeds. Few geologists, he observes, will now be prepared to believe that this single species or genus of reptiles, or that one class only

* From Professor Agassiz, "Monographie des poissons fossiles du vieux grès rouge." Article in Edinburgh New Phil. Journal, July, 1846, p. 17.
The number of species of fossil fishes, in the entire series of formations, are now known to M. Agassiz, to be not less than two thousand.

† Journal, Vol. II., p. 418, 1846.

of vertebrated animals, had possession of the islands and continents, on which so widely-extended and magnificent a vegetation flourished.

With regard to the other supposed impressions of various animals, they appear to be artificially formed; probably by the Indians who occupied the country, and occur under entirely different circumstances to the reptilian tracks near Greensburg. Dr. King agrees with Mr. Lyell in abandoning as spurious all the imprints except those of the large reptile. These reptilian tracks occur in one locality only; no others have yet been found in the same place, nor under similar circumstances elsewhere.

Respecting the traces of organic forms, other than those of vegetables, in the coal formation, we are precluded from entering into details which do not strictly comport with the plan of this work. The shales and argillaceous ore-beds of the coal measures, in most coal-fields, exhibit numerous remains of *conchifera* and *mollusca.* In several instances traces of *fishes* also occur, as we have previously noticed.

In the newer coal formation of Nova Scotia, Mr. Dawson discovered scales of fishes, and traces of shells. But the most interesting discovery in that quarter, is the foot marks of unknown animals, impressed upon the sandstones. They appear to be those of birds, such for instance as are left by the common sand piper when running over a firm sandy shore. The foot-marks of another animal were subsequently observed, and in frequent instances these were partially obliterated by *rain-marks.* Many beds are represented as *rippled,* rain-marked, or covered with worm-tracks, all indicative of a littoral origin. The footsteps of another animal, considered to be a reptile by Mr. Owen, were observed by Mr. Logan. This detection of animal tracks on the coal measures, is announced as the first instance we have obtained of the probable existence of air-breathing land-animals, at any period anterior to the new red sandstone.

Dr. A. T. King, in 1845, discovered, as we have already remarked, undoubted reptilian impressions of foot-steps in the coal measures of Pennsylvania, proving as subsequently observed by Mr. Lyell, the existence of large air-breathing quadrupeds, on the same soil which produced the forests of Sigillaria and Lepidodendron.

In relation to these interesting indications of the early inhabitants of the earth we may be allowed to cite an eloquent authority. "It is strange that, in a thin bed of fire clay, occurring between two masses of sandstone, we should thus have convincing, but unexpected, evidence preserved concerning some of the earth's inhabitants, at this early period. The ripple-mark, the worm-track, the scratching of a small crab on the sand, and even the impression of the rain drops, so distinct as to indicate the direction of the wind at the time of the shower,—these, and the foot-prints of the bird and the reptile, are all stereotyped, and offer an evidence which no argument can gainsay,—no prejudice resist,—concerning the natural history of a very ancient period of the earth's history.

But the waves that made that ripple-mark have long ceased to wash those shores; for ages has the surface, then exposed, been concealed under great thicknesses of strata; the worm and the crab have left no solid fragment to speak to their form or structure; the bird has left no bone that has yet been discovered; the fragments of the reptile are small, imperfect, and extremely rare. Still, enough is known to determine the fact, and that fact is the more interesting and valuable from the very circumstances under which it is presented."*

* Ansted's Picturesque Sketches of Canada.

SECTION IV.

MINING CASUALTIES AND PROVIDENT INSTITUTIONS.

On the mining casualties or accidents, and on the provident institutions, relief funds, benefit societies, *caisses de prévoyance*, *caisses de secours*, and similar institutions which have been established for the relief of working miners, in the principal coal producing countries.

During the preparation of the present work, we had collected numerous statistical facts on a branch of our subject which appeared fraught with unusual interest, namely, that of the casualties to which the coal miner's occupation is especially subjected, and the means which in late years, have been adopted to afford him aid under the many attendant circumstances of privation, sickness and distress.

We had originally distributed these notes under their local heads, but soon perceived that that arrangement was not likely to prove the most useful or convenient; and that the whole matter would be more appropriately disposed in a distinct section. The topic had acquired additional interest in proportion to the accession of information, until it appeared to us that, in a philanthropical sense, few were more entitled to our calm consideration. By no government, probably, has its investigation been carried to a more praiseworthy extent than by the Belgian, and with this conviction, no apology seems necessary for adverting to the opinions and experience of some of her most enlightened official writers.

It will be born in mind that these investigations are especially directed to the case of the operatives engaged in the extraction of mineral fuel, and not in the mining generally of the metals. There appears to be a wide difference in the character of the two classes of employment. Each has its contingent difficulties, each its attendant dangers, but superadded to these are the peculiar, the instantaneous, the uncontrollable risks, in the daily operations of the coal miner. Of all descriptions of subterranean undertakings, it is conceded, that of coal mining is accompanied with the most frequent dangers to the workman; and the most appalling of these dangers arise from causes over which he possesses the smallest control, and which do not attend the extraction of the metalliferous ores. It is this sad experience and the urgent necessity for alleviating its calamitous results, which have called into exercise the aid of the economist; has awakened the sympathy of the philanthropist, has appealed to the aid of the rich and the protection of the powerful, and has united, in common cause, the proprietor, the explorer, and the working labourer.

Influenced by considerations suggested by these and some other obvious circumstances, we have concentrated under one section, and proceed to exhibit in the following preliminary chapter, the data we have collected on the subject of mining casualties and miner's provident institutions, commencing, as we feel bound, with those of Belgium.

BELGIUM.

On the 19th December, 1841, M. Desmaissières, minister of public works, made a report to the king, on the provident or relief funds, "*caisses*

de secours," of working miners, established in Belgium."* We proceed to trace the substance of that excellent report, with the addition of some subsequent notes from the papers of M. Auguste Visschers† and others.

The creation of private "*caisses de secours*," in the vicinity of the Belgian collieries, dates only from the commencement of the present century.

With the enlargement of coal mining undertakings arose more frequent casualties among the workmen and increased demands, on very inadequate resources, to alleviate the consequent distresses. The aid afforded to the sick and the wounded at this period is stated to amount to almost nothing.

It was in consequence of a series of appalling accidents and deplorable loss of life in the mines of Belgium, principally in the department of Ourthe, in 1812, that the attention of the imperial government was attracted to these events, and to the means of ameliorating them. By a decree of the Emperor Napoleon, 26th May, 1812, the first "relief fund" was founded. By another imperial decree, 3d January, 1813, regulations were established concerning a subterranean police. At the entrance of the allied armies the relief fund or chest ceased to exist, and the Netherlands government did not consent to its re-establishment.

The casualties to which we have alluded were chiefly these.—On the 10th January, 1812, sixty-eight miners perished in the coal pit of Horloz; victims of the fire damp. The 28th of February, following, twenty-two workmen were buried in the waters of the mine of Beaujonc. Hubert Goffin, a common workman, saved, by his courage and presence of mind, seventy labourers, who were buried under ground five days and nights. For this act he received the order of the legion of honour.

When the distressing catastrophes in the mines of Cockerill and of L'Esperance, March, 1828, and August, 1829, occurred, the government of the Netherlands granted six thousand two hundred florins; at the same time public charity and the treasury of the mining companies united to alleviate much of the suffering. Seventy-two workmen had perished by these two accidents; eleven others were wounded; but the warning was not yet sufficiently solemn.

On the 3d August, 1831, thirty-six workmen perished, victims of fire-damp, at the colliery of the *Grand veine du bois d'Epinois*.

Upon the 26th June, 1833, twelve workmen fell by the same cause, at the mine of *Petit Forêt*. The following 8th of August, thirty-eight miners perished by an inundation in the coal pit of *Monceau Fontaine*. The 31st of the same month, an eruption of water caused the death of thirteen more at the coal pits of *Sartes*. On the 16th April, 1834, fire-damp caused the death of nine workmen at the mine of *Poirier*. The 18th April, 1835, fifteen workmen lost their lives in consequence of fire-damp, at the coal pit of *Trien-Kaisin*. Sixth of December following, fifteen miners perished by the same cause at the coal pit of *Kessales;* five others were dreadfully wounded. On the 16th May, 1836, an inundation destroyed twenty-nine workmen, in the coal pit of *Sainte-Victoire*. Fourteenth June, following, twenty-two workmen fell victims to the detonation of carbonated hydrogen gas, at the colliery of *Grand-Buisson*. Sixty workmen perished, choked, or burnt, on the 22d of June, 1838, at the coal pit of *L'Esperance* at *Seraing*. The 8th of April, 1839, the "*grisou*" fire caused the death of fifty-five miners, at *Horloz*.

* Rapport sur les caisses de prévoyance en faveur des ouvriers mineurs.

† Notice sur l'establissement, en Belgique, de caisses de prévoyance, Bruxelles, Feb. 1843.

Of the solitary cases of violent death we have no separate record before us, during this period, and many victims fell, isolated, without the public remembering to compassionate and aid their families.

In some of the disasters we have recorded, the royal munificence, the treasury of the state, or private subscriptions, came to the succour of the parents and relatives of the victims. But the great majority remained without any assistance.

We extract the following table from official documents, concerning the accidents that have happened in the mines of the kingdom, from 1821 to 1840, inclusive.

General Cases.

Mining Divisions.	Number of accidents.	Number of Workmen. Killed.	Wounded.	Total.
1st division, Province of Hainault, - - - -	693	878	440	1318
2d " Provinces of Namur and Luxembourg,	80	62	30	92
3d " Province of Liége, - - - -	579	770	442	1182
Total casualties in the Kingdom, - -	1352	1710	882	2592

These cases may be subdivided under eight heads, whereby we are enabled to show the nature of the casualties, their frequency, and the mortality attending them.*

Nature of the accidents between 1821 and 1840.	Number of cases.	Number of Workmen. Killed.	Wounded.	Total.
Falling in of the roof, of stones, coal, &c. -	389	334	114	448
Divers accidents in the pits, - - - - -	262	232	53	285
Ascending or descending by ropes or chains, -	226	261	50	311
Divers causes, - - - - - - - -	146	106	68	174
Fire damp, - - - - - - - - - -	130	505	472	977
Ascending and descending the ladders, - -	95	73	30	103
Explosions by powder, - - - - - -	75	31	79	110
Inundations, - - - - - - - - -	29	168	16	184
	1352	1710	882	2592

Average number of workmen employed, in the Belgian coal mines,	From 1821 to 1830,	25,980
	From 1831 to 1840,	31,500
	Mean of 20 years,	28,740
	Year 1842,	39,277

The cases of fire damp, [detonation of carbonated hydrogen gas,] form the most murderous, if not the most frequent of these accidents. Below is a summary of those explosions that occurred during the period from 1821 to 1840.

Fire Damp.

Mining Divisions.	Number of accidents.	Number of Workmen. Killed.	Wounded.	Total.
1st.—Province of Hainault, - - - - -	70	211	244	455
2d.—Provinces of Namur and Luxembourg, -	2	1	3	4
3d.—Province of Liége, - - - - - -	58	293	225	518
Total in the Kingdom, - - -	130	505	472	977
Or 37 per cent. of the whole, - -		25.16	23.60	48.85

* Rapport au Roi, Statistique de la Belgique, 1842, p. ci.

Thus, within twenty years, thirteen hundred and fifty-two serious accidents have taken place, and two thousand five hundred and ninety-two victims have perished, or have been grievously wounded or maimed. This forms, on an average, one hundred and twenty-nine persons a year, in a population that may be placed at about twenty-eight thousand persons. Nine hundred and seventy-seven individuals have fallen victims to fire damp alone. But the seventeen hundred and ten miners who perished during this time, had wives and children, left in want and misery. In valuing at four, the number of unhappy creatures, dependent for their subsistence on these victims, and who were abandoned without resources, we shall have an amount of six thousand eight hundred and forty suffering beings, whose misfortunes result from the working of the coal mines.

In November, 1841, a dreadful explosion took place in the coal mines of P. Felix, Hainault, at a depth of 1450 feet, causing the death of thirty miners.

In May, 1845, another disastrous explosion of fire damp occurred in the bottom of a coal pit, at *Boussu*, near *Quirrain*, where no less than one hundred and forty out of two hundred miners, who were at work at the time, lost their lives.

An explosion of fire damp took place in a colliery near Mons, March 22, 1847, at a time when fifty men were below. Of these, twenty-six were killed, and the remainder were all, more or less, wounded seriously.

The recently published Report of the Belgian mines, from 1840 to 1844, enables us to complete, so far, our table of the number of workmen who were killed or wounded by *explosions of fire damp*.

	Number of cases.	Number of Workmen injured.		
		Killed.	Wounded.	Total of Victims.
From 1821 to 1840,	130	505	572	977
1840 to 1844,	64	122	180	302
In twenty-four years,	194	627	652	1279

Mining Accidents—from the "Compte Rendu de 1839–1844."

First division of Mines—Province of Hainault.—During the period from 1840 to 1844, inclusive, the working the mines of this province has occasioned 572 grave accidents, and caused to perish 291 workmen, and wounded 494 others,—785 victims.

The mean number of workmen employed in the mines of the first division during this period, was 27,512. It appears, therefore, that for each thousand miners, there were twenty accidents and twenty-eight victims, of which eighteen have received wounds, and ten have been deprived of life.

Second division—Provinces of Namur and Luxembourg.—From 1840 to the end of 1844, fifty two accidents occurred. The number of victims was sixty-six, of which thirty-seven perished, and twenty-nine received serious wounds.

The average number of miners employed during this interval, was 2450. Thus, for every thousand workmen, there were twenty-one accidents,—eleven persons wounded and fifteen others killed; that is to say twenty-six victims.

Third division—Province of Liege.—One hundred and fifty-one accidents, killing 218, and wounding 57: total, 275 victims.

The average number of miners working in this district was 10,932. Consequently, for every thousand workmen, were thirteen accidents, five persons wounded, and twenty killed; that is to say, twenty-five victims.

General Review of the Accidents which happened in the Coal Mines of Belgium from 1840 *to* 1844, *inclusive.*—Number of accidents, 775; deaths in consequence, 546; severely wounded, 580,—total number of victims, 1126.

Average number of miners employed at this period, 40,894. This is nineteen accidents, fourteen persons wounded, and thirteen killed; total victims, twenty-seven for every thousand.

Table of the Nature of these Accidents, arranged in the order of their frequency or number.

	Number.
Falling of stones, crushing of roof, &c., - -	271
Divers causes, - - - - - - - -	159
Accidents in the pits, - - - - - -	120
From ropes and chains, - - - - - -	68
Fire-damp, coups de feu, "*grisou,*" - -	64
Falls from ladders, - - - - - - -	47
Explosion of powder, - - - - - -	33
Inundations, - - - - - - - -	13
Total,	775

In the table below the same accidents are classed after the *order of their importance.*

Nature of the Accidents.	Number of Workmen.		Total of victims.
	Wounded.	Killed.	
Fire damp, - - - - - - - - - -	180	122	302
Fall of stones, crushing in, &c., - - - - -	158	134	292
Various causes, - - - - - - - - -	107	64	171
Various accidents in the pits, - - - - - -	45	93	138
From ropes and chains, - - - - - - -	27	72	99
Falling from ladders, - - - - - - -	30	19	49
Explosion of powder, - - - - - - -	27	12	39
Inundations, - - - - - - - - - -	6	30	36
Totals, - - - - - - -	580	546	1126

In pursuance of this momentous subject of coal mining accidents, the recently published report of the mining operations between the years 1840 and 1844, inclusive, developes some interesting statistics. It is seen that while the production of coal in the kingdom has increased twenty per cent., the number of working miners has only augmented seventeen per cent.

In the same lapse of time the total number of these disasters augmented thirty-nine per cent., and that of the victims have increased only nineteen per cent. This augmentation of the number of victims bears principally upon the wounded, which has increased fifty-two per cent, while the number of killed has diminished to fifteen per cent.

The following table, derived from the "Compte Rendu de 1839–1844," is arranged in the order of importance of the several classes of accidents, at separate periods of time, and calculated by the actual per centage in every thousand workmen.

Nature of the Accidents.	In every 1000 Workmen killed or wounded, the result is thus.		
	Period from 1821 to 1840.	Period from 1835 to 1839.	Period from 1840 to 1844.
Fire damp,	377	378	268
Falling of rocks, stones, coal, &c.,	173	193	259
Divers accidents,	177	185	274
Falls from ropes, chains, ladders, &c.,	160	159	132
Explosion of gunpowder,	42	38	35
Inundation,	71	47	32
Totals,	1000	1000	1000

The increase or decrease in each class of accidents is rendered sufficiently apparent without further comment. We would only notice that, contrary to prevailing opinion, founded on the increased depth of the mines, the loss of life by fire damp has remarkably declined. The accidents attributable to the crushing in of the roof, the falling of stones, coal, &c., has more than proportionately increased within the same period of time.

The magnitude of the catastrophe that occurred at the coal works of *L'Esperance*, at length attracted serious attention. During the years 1839, 1840 and 1841, the subject of establishing relief institutions in the mining provinces was advocated by the ministry, and eventually decided by several royal decrees. The archives of the ministry contain several propositions which were made upon this subject. M. *Auguste Visschers*,* the present director of the administration of the Belgian mines, published an article which attracted much notice, and which has been reprinted in 1843. It is entitled, " Notice of the establishment, in Belgium, of Provident Institutions, caisses de prévoyance, for the benefit of the Working Miners."†

In the subjoined note, A, will be found the titles of many of the publica-

* To whom the author of the present volume is personally indebed for valuable documents on this interesting branch of statistics, and from which he has not hesitated to make copious extracts.

† Literally, " foresight chests;" the object being not merely to afford relief, but to encourage in the mining population habits of foresight. Mining Review, Vol. XII. p. 167, 171.

Note A. *Caisses de prévoyance.*—The following publications treating more or less directly upon this subject, have been printed in Brussels of late years.

I. *Rapport sur les Caisses de prévoyance en faveur des ouvriers Mineurs*, presented to the king by M. Nothomb, Minister of Public Works, 24 June, 1839.

II. *Rapport sur les Caisses de prévoyance en faveur des ouvriers Mineurs*, presented to the king by M. Desmaisières, Minister of Public Works, 19 December, 1841.

III. *Rapports Annuels des Commissions Administratives des Caisses de prévoyance en faveur des ouvriers Mineurs, instituées dans les Provinces de Hainaut, de Liége et de Namur*; several years.

IV. *Rapports sur les Institutions de Bienfaisance du Royaume*; official reports in 1825, 1826, 1827, 1828, &c.

V. *Essai sur les Moyens d'améliorer le sort des ouvriers*, by Count Arrivabene, 1832.

VI. *Des Caisses d'épargne et de leur Influence sur les Classes Laborieuses*, by M. Ducpetiaux, 1831.

VII. *De la Condition Physique et Morale des jeunes ouvriers et des Moyens de l'améliorer*, by the same, 1843.

VIII. *De l'establissement de Caisses de prévoyance en Belgique, en faveur des ouvriers Mineurs*, by Auguste Visschers, 1839 et 1843.

IX. Eleven publications and reports upon the same subject, in relation to local establishments in the provinces of Liege, Hainault, Namur and Luxemburg, and the arrondissements of Mons and Charleroi,—1839, 1840 and 1841.

The generous bounty of the king, appreciating the acts of heroism and courage to which the accidents in the collieries frequently give rise, has expressly instituted a medal of recompense in favour of working miners. The royal decree of the 19th October, 1840, determined the form and model of this medal, divided into two classes, [gold and silver.] Both of them bear on one side the effigy of the king, and on the reverse the insignia of the miner's profession, with these words inscribed upon the exergue:

ACTE DE DEVOUEMENT, RECOMPENCE NATIONALE.

tions which appeared in Brussels, in relation to this subject, by distinguished writers. To these works we will refer those of our readers who desire more detailed information on a matter of no ordinary interest.

We have only to add in this place a short resumé of the general plan and condition of these useful institutions, chiefly on authority of the reports of M. Desmaisieres and M. Visschers.

The organization of the *caisses de prévoyance* in the five subdivisions of the Belgian coal basins, is the same throughout. The statutes are approved by the king: the governors of the provinces preside over the administrative commissions, which are composed of "exploitants" and master workmen, and render annual accounts to the governors. The resources for these institutions are derived from deductions from the wages of the men, equal to one-half per cent., and from contributions of the mine owners to the like amount. Each year, since 1840, the legislature has voted about 42,000 francs; three important societies contribute at least 5000 francs; the provincial council at Hainault annually votes 6000 francs: to these may be added the funds derived from endowments, and from the donations and bequests of individuals. Independently of the temporary relief afforded to the widows, orphans, and dependents on the deceased, the benefits are still further extended by furnishing the means of instruction to the children. Thus, the institution, in providing for the moral wants of living generations, contribute to ameliorate the future condition of the working miner. The benefits are not limited solely to the alleviation of the physical necessities.

The beneficial effects of this system are best evidenced by the practical working since its introduction. On the 1st January, 1842, the proportion of mining establishments, [exploitations,] associated on the foregoing principles, and the number of workmen who had enrolled themselves as members, were as follows:

	Exploitations.	Working miners.
Affiliated exploitations, forming societies, .	210	31,971
Establishments not yet associated, . .	160	7,306
Total in the kingdom, ...	370	39,277

Hence we perceive that the affiliated coal establishments of Belgium amounted to fifty-seven per cent. of the whole number, and the workmen attached to the provident societies were not less than eighty-one per cent. of the aggregate mining population. This is the best indication of the general approbation, by the miners themselves, as well as the owners and lessees of the collieries, of these institutions, throughout Belgium.

"Thus, happily," concludes M. Desmaisieres, "have these humane projects been most nobly brought about, by the influence of the proprietary, by the wisdom of the government, and by the parental solicitude of the sovereign."

The working miner, left to himself, has not the foresight, and does not possess the influence necessary to bring to a good issue such projects as these. It is then for the manufacturers and for the civil administrations to set on foot the establishment of beneficent and relief funds. Modern philanthropy has nobly pleaded the cause of the workman. What is important above all, is to protect him against the reverses which continually threaten industry, in all the gigantic extension to which it has reached. It is not enough to provide for his health—for his comfort—he ought to be habituated to reflect as to the future. Once accustom him to do this, and the workman will become more moral; because he will be persuaded that his condition is ameliorated.

GERMANY.*

The mining art was early diffused through the states of Germany. Various edicts granted privileges, or what were then called franchises, to the cities of the mineral districts.

In the greater part of these ordinances we perceive "dispositions protectrices" to the workmen; particularly the assurance of certain aid to himself and to his family, in cases of accident.

The ordinances of 1524 and 1538, made for the mines of Hartz, [Hanover,] assured to the wounded labourer, besides medical aid, the enjoyment of his pay, for eight weeks, if the working company made profits; but only during four weeks if it lost. Hence we observe that it was the mining company on whom the expense devolved.

A similar ordinance, of the 22d July, 1564, made in the electorate of Trèves, reserved a certain weekly sum from all the workmen's wages, towards these objects. This is the earliest edict which makes mention of a reserved fund, introduced by fixed regulation.

An edict of the margrave of Brandebourg, 20th Oct. 1599, bestowed franchise and privileges on the city of Tarnowitz, in Silesia. Art. I. of this act founded a common fund, to be supported by moneys retained from the pay of the working miners. Its object was to contribute to the foundation and the construction of churches and schools, and at the same time to afford Christian assistance to the wounded workmen; or, in case of death, to their widows and orphans.

We will not here enumerate all the ordinances prescribed in favour of the mining workman, and the establishment of common funds. Similar institutions exist even in SWEDEN, for the working forgemen, sick or wounded; each owner of forges, every master forgeman, contributes. The simple workman bears a reserved amount equal to the half of that which is contributed by the master forgeman.

Germany presents us, from an early period, an example of two institutions by which we might profit. 1. Mutual insurance funds for poor *mines:* 2. Relief societies—"caisses de secours"—for the *miners*.

The first of these institutions is especially useful in the infancy of the art of working the mines; but when,—extraction having attained considerable amount,—the production tends to exceed the requirements of consumption, is all insurance between the mines, all association for works of general utility superfluous? The system of insurances against risks of every kind has only been developed within a few years, in Belgium and in France. Mines are penetrated with the necessity of remedies against the evils of unlimited competition; against the disorders which it has tended to produce. Even in Belgium, already, one of our financial societies has suggested the formation of a species of institution, [syndicat,] for the industry of the high-furnaces and forges. These ideas should not be lost. Public riches as well as private fortunes suffer from the disorders of excessive competition; of an imprudent excitement, given to the productive forces. The history of late years should serve us as a warning.

"Caisses de secours" for poor miners, wounded or sick, at length exist in Belgium, but the government alone could not have established them. In Germany, the development early given to the "exploitation" of mines; the important number of workmen devoted to this branch of industry; the

* Abridged from the "Notice sur l'éstablissement, en Belgique, de Caisses de Prévoyance, en faveur des Ouvriers Mineurs." Bruxelles. 1843.

revenues which the princes derived from it; the influence which they enjoyed in these mine operations, by virtue of the principle which attributes them to the sovereign, [droits régalien,] have induced the depositories of power to regulate all that which concerns the extraction from the mine, the duties, and the relations of masters and servants. Sacrifices were at first alone imposed on the working companies; subsequently the workmen were called on to contribute. The princes granted subsidies or privileges to the "chests"; in many of the mines free action was reserved to the benefit fund.

These institutions were regulated by some suitable persons, chosen by the officers of the prince. The funds were inclosed in boxes having several keys. Sometimes also the workmen bore a part in the directing commission.

The working miners were not, in Germany, and are not now, abandoned by their masters: the authorities are careful to provide for their necessities. These chests were sometimes very rich. According to Jars, the revenues of the *Caisse* of the poor miners of the department of Freyberg, amount annually to 24,000 livres: about the year 1757, the capital, invested at five per cent. interest, was 32,646 livres.

THE PRUSSIAN STATES.

As regards legislation over the aid afforded to the workmen, in mining casualties, the articles 214 to 220, of the general code of the Prussian states, were formed, in order to generalize and reproduce the various local statutes. It is unnecessary to cite them here.

Finally, public authority has recently sanctioned regulations for th e established provident institutions, in favour of working miners, in *Rhenish Prussia.*

GREAT BRITAIN.

What the wise direction of public authority has established in Germany, the spirit of association, the sentiment of individual independence, the habit of calculation and of observation, have consecrated in Great Britain. The associations of provident institutions, of saving, of insurance, of charitable, friendly and benefit societies and clubs, in this country, have been clothed with the popular character, always visible in all its institutions. However, the patronage of the higher classes is not refused. It is probable even that these establishments have been originated by the masters or by the mining companies; but these parties have placed themselves in the back-ground of the picture. The charitable or friendly societies have become now part of the customs of the English people. The soil of Great Britain is covered with them.

We have consulted the documents relating to the benefit societies, or those of mutual assistance, in several parts of the United Kingdom. In general, although the donations of distinguished patrons, or those of the proprietors, are welcomed, the major part of the funds is supplied by the workmen; not by means of a voluntary assessment, but by virtue of statutes to which they submit on entering into the establishment.

These institutions participate in the character of insurance societies, but they present this peculiarity, that they are not, to any one, the object of lucre or of a speculation. They possess the defects of the societies of mutual help; inasmuch as, in general, they apply only to a small number of individuals. But the wisdom with which the funds are guarded, the prudence which they exercise not to encroach upon the reserve, show that the incon-

veniences are at least but slight. The workman knows that the "chest" is only maintained by his contributions; he knows that the funds cannot be diverted, and he makes no complaint, in any case, of the insignificance of the aid he receives in proportion to the sacrifices that he has made.

Nevertheless, the funds are, ordinarily, sufficient, and in affinity with the wants of the members. The proprietor of the English mines interests himself in the lot of his workmen. He takes pride in seeing them well-ordered and economical. For his own advantage, he constructs, for the use of his work-people, habitations convenient to the seat of their operations. He gives them, sometimes, dwellings gratuitously. He founds schools for the children; he furnishes a place for a common library. He contributes to the stock for mutual assistance, placed under his patronage; he holds the funds, and pays the interest on them.

In England especially,—and the attempts to reform the poor-laws demonstrate it,—they seek to avoid the inconveniences of those institutions which are solely charitable or purely helpful. The superior classes, so enlightened in this kingdom, interfere in these institutions only to facilitate their operation. The government, whose action ordinarily remains latent, limits itself to the publication of the precise formula for the regulation of the various societies of insurance or benefit.

These societies when they have acquired some extension, are very careful to solicit and secure legal sanction. An advocate of the crown is appointed to review the rules of the associations which aspire to be incorporated. The acts of Parliament, 10 Geo. IV. and 4 and 5 William IV., fix the course to be pursued, and the final sanction is accorded by the magistrates of the county.

The numerous philanthropic societies in Great Britain second the tendency of the English people to profit by the benefits of co-operation. Association, in the times to come, will produce such wonders as we owe, in the order of physics, to the accumulation of steam, or to electricity. It is a lever or powerful spring, which till now has been employed but imperfectly; but which, well directed, will be the principle of prodigies which the future will disclose.

The English workman is, in general, better instructed, and is in easier circumstances, than those of Belgium. He not only has a love for his profession, but entertains a great respect for his superiors and for the laws. The habit of economy, the advantage he finds in it, the pride which the sentiment of his power and good conduct gives him, contribute to strengthen these moral ties. We speak not now of the workers in the great manufactories: reduced to the state of paupers; ill fed; exposed to every privation. But the working miner is, in this kingdom, in a more favorable position than the Belgian miner.

There are two traits of character in the English workmen that we must not lose sight of:—the care that they take to provide a suitable and religious burial for their deceased comrades, and the importance which they attach to the education of their children.*

The picture thus presented by M. Visschers, of the condition of the English miners, is drawn by a friendly hand, and perhaps may be considered somewhat flattering.

To the foregoing liberal views of this philanthropist, we proceed to note some prominent statistics on the miners' Benefit Societies, and on the casualties of coal mining in England; a country which has perhaps a greater interest in these subjects than any other, being the largest coal producer, and

* Notice sur l'establissement de Caisses de Prévoyance. M. A. Visschers, 1843, p. 18.

employing a more numerous population in its extraction, than the rest of the world united.

The continuance of voluntary subscriptions to the innumerable provident societies of the mining districts, proves the prevailing reliance on their efficacy in times of emergency; while the almost universal enrollment, as contributing members, of the class of operatives especially interested in the result, attest the estimate which has been formed, by the working miners themselves, of the salutary influence of those associations. Local instances, we are constrained to admit, may be cited where abuses have existed; where the system has been rendered less operative for good by defective arrangements; by erroneous calculations at the outset; or by occasional improvidence in the management; such, for instance, as has been shown by a Parliamentary Report of the South Staffordshire coal-fields; a district which has acquired a lamentable notoriety, for the habits and the moral and social condition of its mining population. But the general working of the relief funds and provident societies, throughout the length and breadth of the land, is satisfactory: creating habits of foresight and economy—compulsory probably at first—and, above all, estimable in bringing opportune succour to the maimed and the sick, and relief to the infirm; in providing support to the survivors of those frightful accidents which so often occur; in securing decent burial to the dead, and, in affording consolation to the families of such as have unfortunately perished.

The drawback on the utility of the ordinary country clubs, seems to consist in their local operation and restricted character; in the limited and fluctuating nature of their resources. Often based on erroneous data; frequently originating with, and conducted by, the uninformed; isolated in all respects;—they want the power and uniformity, almost amounting to nationality which the coherence of the Belgian confederated *exploitations*, guaranteed by the solemn sanction of the government and laws, seems to assure to the individual societies of which they are made up.

In England there are no public institutions to supply the deficiencies of the country club system. It has been even considered better to leave the supposed evils to be corrected by the interested parties themselves. Moreover it is contended that the extension of especial public protection and relief in favour of one class of operatives, is incompatible with strict justice towards numerous other classes who also pursue hazardous occupations; such, for instance, as the sea service, in which 2,000 British sailors are annually estimated to perish by shipwreck; which appears very little to exceed the number of the killed and disabled miners.

Violent deaths, which occurred in 55 mining districts of England and Wales, in the year 1838.

By falling down shafts,	63
Breaking of ropes,	1
Ascending and descending,	10
Drowned,	22
Falling of stones and coals,	97
Explosions of gas,	88
Explosions of gunpowder,	4
By trams and wagons,	21
By various injuries,	43
Total,	349

Mining Casualties in the South Staffordshire Coal District.—This district has been recently investigated by the "Midland Mining Commission,"

and forms an important part of their able Report, drawn up by Mr. Tancred. He remarks, "I come now to, perhaps, the most distressing part of my subject, on which I have to present details which I am persuaded must shock the feelings of all who read them; I allude to the frightful amount of accidents and loss of life which is day by day leaving the fatherless and widows to lament the sudden loss, in the midst of health and vigour, of those on whom they depended for support.

"I should hardly have been disposed to investigate this subject so minutely, had I believed that such a destruction of human life was a necessary and inevitable accompaniment of the working of the thick-coal seam; for in this by far the most danger is incurred. On the contrary, however, I shall have the consolation of proving that such is not the case, and shall produce instances in which a gratifying contrast to the general course of things is exhibited."*

The writer proceeds to quote the records of the "General Registry Office," which furnished the following appalling results.

Table of the deaths of miners in the Dudley Coal-field, in 5½ years, viz. from July 1837 to December 1842, and the proportion of such deaths as result from accidents, in eleven parishes, whose population in 1841 was 221,018. We may observe that in this population there appears to be no registry or estimate of the total number of miners, so that we are deficient in the means of comparing the results with other districts.

Deaths of miners, of 15 years and upwards, in 5½ years, -	1122
Of the above number killed by accidents, - -	610
Proportion per cent [being 54.3 killed, out of every 100 deaths,]	54.3
Average age of miners at their deaths, years, - -	36⅔

Thus every miner has more than an equal chance of being killed, in pursuing his occupation.

According to a return by Mr. Best, manager of the large works of the British Iron Company, the proportions of casualties, in the Netherton colliery, were, in 1842, or rather for 45 weeks in that year, as follows:

	Men employed.	Accidents.	Of which were fatal.	Accidents per cent.	Deaths per cent.
In the thick coal pits,	82	59	4	72	5
In the thin coal and iron-stone pits,	92	67	0	73	0
	174	126	4		

As during this year, 1842, the works were inactive for seven weeks, on account of the strike of the men, if we take the proportion for the entire year or 52 weeks, the result shows a total of near 146 accidents, sufficiently serious to prevent men from working, out of 174 mines.

Mr. Best adds, that in the same year was paid, to the sick colliers, miners' widows and orphans in that establishment, upwards of £560=$2,721.

Mr. Smith, manager of the property of the Earl of Dudley, employing 1054 miners, funishes the following statement also for the year 1842, or for 45 weeks only.

Thick coal colliers, - - - - -	429
Thin coal and ironstone miners, - - - -	290
Limestone miners, - - - - -	335
	1054 men.

Medical relief, and pensions paid to wounded and superannuated miners and widows, £960 9*s.*—$4,658.

* Midland Mining Commission, First Report, 1843, p. liv.

From the details of the mining casualties in this region, it appears that none have been occasioned by inundation, and very few by explosions of fire-damp. This gas appears to be not engendered by the Staffordshire coal, so abundantly as in most other fields; the men usually working with open candles.

The reporter goes on to state the remarkable circumstance that, with so great a number of frightful accidents, constantly occurring, there is nothing in the shape of a hospital in the whole mining district, with the exception of a few in-door patients at the Wolverhampton Dispensary. All other cases, requiring peculiar skill, must be sent to Birmingham.

A serious case of explosion occurred on the 18th August, 1845, at Tividale, near Dudley, when twenty miners lost their lives. Among other cases may be added that at Round's Green colliery, near Oldburg, by which twenty lives were lost, on the 17th November, 1846, leaving fourteen widows and one hundred and two orphans destitute.

Benefit Clubs in the Dudley or South Staffordshire Coal-field.—The report from which we have last quoted, examines into the nature of the associations among the miners of this district, for the relief of the members in sickness, and for their burials, and allowances to their widows. "These institutions, so beneficial in themselves, and so well calculated, if properly regulated, to counteract the habitual improvidence of the workmen, and to compensate, in some small degree, for the absence of a wealthier class living amongst them, are, by the perverse ingenuity of interested parties, converted into one of the numerous means by which the hard-earned wages of the miner are transferred from his pocket to the till of the public house."

We cannot enter here into the details which appear in the pages of the report. It is evident enough that the practical working of the system is greatly in need of amendment; and, indeed, occasionally is productive of injurious consequences. The evidence shows that these clubs are always held at public houses, and are promoted by the publicans for their own benefit. By reason of the abuses of the system, and of the appropriation of the funds to drinking and unnecessary expenses, the results are far less beneficial than they might be.

The "*friendly societies* or *sick clubs*," are very numerous, and are established on various principles. They engage with a medical man to attend the members during sickness; and he is paid from 2*s*. to 4*s*. [fifty cents to one dollar] per annum, for each member enrolled. It is a general rule, that if a member continues a charge on the sick fund for twelve months at one time, he is reduced to half pay for life, and allowed to follow his employment if he is able.

There are also "*Odd Fellows and Lodges*," established on the same principle as the clubs, with the addition of the ceremonies and feasts, but as these are attended with considerable expense, the steady mechanics prefer the common "*sick clubs*."

The "*Field Clubs*" are confined entirely to the miners, and afford medical attendance and sick-pay only during illness from accidents occasioned by the work. The payments to these clubs are compulsory, and the employer always stops the contributions, out of the wages of the men. The miners are very generally in a sick or "*life club*," in addition to their "field club."

Mr. Simkiss, from whose evidence we extract the foregoing notes, adds that "all the clubs or societies, in this neighbourhood, must be founded on erroneous principles, as they are of short duration. The oldest I can find have not been in existence more than seventy years; and by far the majority

do not last one third of that time." For some years, when new members are joining, and the funds are consequently increasing, they appear to be in a prosperous condition. But when the original members grow old and become a serious charge on the funds, young men look out to join younger clubs. The original club first becomes stationary; then as the deaths increase the funds decline, the numbers diminish; and, after struggling for awhile, they ultimately divide what little stock is left among the few survivors. Thus, those who have, during life, contributed regularly, with an assurance of provision in their old age, are now, when they want the most, left with nothing to depend upon but parochial relief.

The miners and mechanics, generally, make no provision (with the exception of clubs,) for the wants and infirmities of old age. There are very few who ever make any deposits in the *savings' bank*, and the instances of miners becoming depositors, are so few, that we may almost say, there are none of that class."

Besides the voluntary clubs above mentioned, established by miners themselves, there is a regular system of relief for men wounded or killed in the service, and also to their widows.

In the thick-coal mines, [ten yard coal] the custom is for the owner of the mine to allow 6*s*. a week to the wounded; and 1*s*. 6*d*. a week to the widow of any man killed; together with 1*s*. a week to each child which she may have under the age of ten. The men on their part, make a special collection at every weekly pay, for any wounded man, or widow of a fellow workman, of as much as will make up another 6*s*. weekly.*

The most mischievous sort of clubs, both to the finances and the morals of the miners, are what are called "*money clubs;*" being subscriptions to certain funds, which are very abundant in the South Staffordshire coal district, all which money is spent in drink at public houses. By the evidence of the resident clergy, the regulations and conduct of some of the clubs here are "terribly destructive of the morals and the savings of the workmen."

It is due to the clergy of this district to state that they strenuously exerted themselves to induce the adoption of clubs conducted on sounder principles, as well as other institutions calculated to remove the evils complained of. Here are "*Provident societies,*" for savings and for relief in sickness, in connection with Sunday and day schools. There are also "*Wesleyan Clubs,*" and "*Clothing Clubs;*" the latter have a beneficial effect in inducing habits of saving. To these we may add the "*Dorcas societies,*" consisting of charitably disposed ladies, who hold stated meetings, and make articles of clothing which are sold to the poor at half the price of the materials.

A series of articles on Benefit Societies, by Dr. Beard, was published in the "People's Journal" in 1847. From these we learn in detail how extensive and almost universal are the failures of the English Benefit associations, arising from defective management, and from the erroneous structure of their respective constitutions.

In the "Odd Fellow and Friendly Societies" the scale on which they have failed—and, unless great changes are introduced, will fail—is, according to Mr. Nelson, fearfully large. The Rev. Mr. Sherman lately stated at a public meeting in Liverpool—'Mr. Ansell had told him of two thousand societies having been submitted to him in three years, whose affairs were proved to be altogether insolvent.' "But," observes Dr. Beard, "there

* First Report of the Midland Mining Commission, p. li.

is another kind of failure: the staff breaks under the hand of the poor sick, aged man, the first time he leans on it. Benefit societies, in numberless instances, *do not* afford the needful aid."

We trust there needs no apology for calling attention, through the medium of the foregoing passages, to the defective construction of associations which were designed for the most useful and beneficial purposes.

The extent of their failure can scarcely be fully ascertained; for the sufferers are in humble life; are scattered up and down in society, and have no sufficient means of making their injuries known. A committee of the House of Commons is the only resource by which benevolent men could acquire some knowledge of the number of these failures, and of the sufferings they have entailed."*

Cornwall.—"The diseases of miners," forms the subject of a paper by Sir Charles Lemon, addressed to the Royal Institution of Cornwall: and also another by Dr. Barham. They contain some very important statistical statements respecting the deaths and diseases among the mining population of Cornwall, and a series of comparisons between the mining districts of Cornwall and the coal regions of Staffordshire, Northumberland, &c.†

Miners' Club.—It does not appear that provident associations, of much utility or permanent character, prevail in the mining districts of Cornwall, and the want of a better system there has been frequently deplored. Various plans for the establishment of hospitals, mining schools, and beneficial societies, founded on an adequate scale and based on correct principles, have, from time to time, been ineffectually advocated in Cornwall. That of a general miners' club is the last.

In 1846, efforts were made to engage the public sympathy in favour of this association, and an earnest appeal was made to the lords and adventurers to give their countenance to the plan, and to support the wishes of the great body of miners. The project for a "Miners' Society" had previously been abandoned, for want of the requisite co-operation of the influential classes.

It was urged that necessity and policy required the establishment of a provident association in every district, or of branches emanating from one general society or club, which should be based upon such principles as should amply provide for the necessities of the labouring miner, when, through the various risks, inseparable from his hazardous avocation, he should be incapacitated from labour.

If, as we infer from the address of some of the advocates for this general club, the thirty thousand miners are to contribute their full share of the annual funds, and the lords and adventurers, and benevolent persons to supply the other moiety, as in the case of the Belgian "*caisses de secours*," the project appears to be unobjectionable; for it has been well proved, that no plan works well as a merely charitable institution giving gratuitous aid; no project is successful in teaching the importance of foresight and timely economy, which does not comprise the contributions of the working miners themselves, and constitute them joint guardians of the funds destined to relieve their future wants.

Mining Accidents in Great Britain.—The Mining Journal, January, 1844, published a list of four hundred and eighty-three deaths and accidents noted in its columns during the previous eight months.

Out of one thousand one hundred and twelve deaths of colliers only among that class of population, reported by the Midland Mining Commis-

* The People's Journal, July, 1847. † Mining Review, August, 1839, and 1841.

sion, no less than six hundred and ten arose from accidents; by which it appears there is a frightful advance of mining mortality. The editor conceives that "the number of lives sacrificed annually, cannot be less than two thousand five hundred, exclusive of the numerous cases recorded in which severe injuries have been received, resulting ultimately in the loss of lives."*

It is due to Mr. English to state that he has for a considerable time past, done his utmost towards the humane object of establishing institutions for the relief of the sufferers by accidents in mines, and has let no opportunity pass of awakening sympathy in favour of that unfortunate class. We fear that there is too much truth in the following severe remark:—

"England is justly proud of her numerous charities, her hospitals for the sick and maimed, her asylums for the aged and decayed members of society, and her institutions for the support and protection of the widow and orphan. But, with shame be it spoken, a country indebted, in a great measure, for her position to her mineral riches, cannot reckon, amongst her numerous charitable establishments, one which is devoted to the maimed or aged collier or miner, nor a [public] fund wherewith to support the widow and the fatherless who may be bereaved of their natural protector by accidents in mines."†

The same gentleman, in a petition to the House of Commons, dated 28th January, 1846, stated that the loss of life in mines and collieries within the preceding year, was upward of a thousand individuals.

A printed statement has subsequently appeared, wherein it is shown that in twelve cases alone, in thirty-two years, there was sustained a loss of seven hundred and twenty-three lives, in the Durham and Northumberland coalfield, chiefly by EXPLOSIONS in the pits. We add the details below.

Date.	Localities.	Lives lost.	Causes.
1812, May 25th,	Felling,	92	Explosion.
1815, May 3d,	Heaton,	75	Inundation.
do. June 2d,	Newbottle,	57	Explosion.
1821, October 23d,	Wallsend,	52	do.
1823, November 3d,	Rainton,	59	do.
1835, June 18th,	Wallsend,	102	do.
1839, June,	St. Hilda,	32	do.
do. June 23d,	South Shields,	51	do.
1841,	Wellington and Thornley,	41	
1843,	King pit,	28	
1844, Sept. 28th,	Haswell,	95	do.
1845, August 21st,	Jarrow colliery,	39	do.
	Cases of death,	723	

A petition was presented to the House of Commons in 1843, by the pitmen of the Tyne, the Wear, and the Tees, in which they state that within the preceding twenty years upwards of *seven hundred* pitmen, the friends and companions of the petitioners, had been miserably destroyed in the Durham and Northumberland mines, by explosions of inflammable gas, and that others met the most fearful deaths from various other causes; that these explosions have always been traced to the want of sufficient ventilation, permitting the accumulation of the gas in such masses that, when set fire to, it explodes with sufficient force, sometimes, to blow men up a shaft six hundred feet deep as if from the mouth of a cannon, and to shake the solid

* Mining Journal, January 20th, 1844.
† Mining Journal, Vol. XIII. p. 391; also, 31st January, 1846.

ground similarly to an earthquake. They state that, knowing the Davy lamp is liable to fire an explosive mixture under certain circumstances, they cannot rest satisfied with their lives being secured by an imperfect instrument, easily deranged, and which at the moment of greatest danger brings on the mischief it is intended to prevent, and on the supposed safety of which has been based the modern practice of carryiug foul underground workings to a most dangerous extent.

The petitioners, who assembled to the number of fifteen thousand, at their meeting, suggested that the only way of working the mines with security, would be by sinking two shafts at the "winning," and as the work extends making additional shafts. The mine would then be thoroughly ventilated, the coal more easily worked, and the petitioners secured from these terrible accidents.

Mining Casualties in the North of England.—The list we have given of the loss of life, chiefly by explosions in twelve cases alone, in the counties of Durham and Northumberland, by no means exhibits the entire number of deaths there from that cause.

The subjoined statistical table shows that they comprised in eighty years, between 1756 and 1836, the destruction of one thousand four hundred and twenty-seven miners. The cases of explosions, more than one hundred in number, were attended by the loss of one thousand three hundred and one lives, out of this complement of one thousand four hundred and twenty-seven. A large extension to this catalogue might be made by the addition of the cases since 1836, in fact, amounting to many hundreds.

Period.	Causes.	No.	Total deaths.	Annual deaths.	
1756 to 1800.	By explosions,	305	311	7¾	
	By inundations,	6			
1800 to 1815.	By explosions,	332	424	26¼	
	Inundations,	74			
	Bursting of steam-boiler, locomotive,	18			
1816 to 1836.	By explosion,	664	692	34½	About 21,000 persons employed above and below ground.
	Inundation,	3			
	Suffocation,	7			
	Falling of stones,	6			
	Bursting of steamboilers,	12			
			1427		

These tables can only be usefully compared with each other, and with the results of other mining districts, when we know the number of workmen actually employed at those times and places respectively. According to Mr. Buddle, the foregoing list of deaths does not comprise those which result from the ordinary casualties of life.*

The following statement has been published of six cases of fire-damp in the Jarrow colliery, on the Durham side of the Tyne, and the number of deaths they occasioned.

In 1817, 1st explosion,	- - - - - -	6 killed.
1820, 2d "	- - - - - -	2 "
1826, 3d "	- - - - - -	42 "
1828, 4th "	- - - - - -	8 "
1830, 5th "	- - - - - -	42 "
1845, 6th "	- - - - - -	39 "
In twenty-eight years,	- - - - - -	139

* M. Piot in Annales des Mines, Vol. I., 1842.

The attention of the government has been attracted to the formidable nature of these explosions, and in recent important cases, it has nominated commissions, consisting of gentlemen of science and experience, to such as in the cases of the Haswell and the Jarrow explosions, and have directed a searching investigation to be instituted into the causes which led to these catastrophes.

The quality of the deleterious gases of the Jarrow, the Hebburn and the Gateshead collieries was examined in 1846, by Mr. Thos. Graham, and the Mining Journal of June 16th contains an article by that gentleman, "on the composition of the fire damp of the Newcastle coal-field," and the result of his investigation. From this paper it appears that the gas of Killingworth colliery, near Jarrow, where the great explosion of 1845 took place, issues from a fissure in a stratum of sandstone, and has been kept uninterruptedly burning, as the means of lighting the horse road in the mine, for upwards of ten years, without any sensible diminution in its quantity. At the Gateshead colliery, also, the gas is collected as it issues, and is used for lighting the mine, while at the Hebburn colliery the gas ascends from a bore made down into the Bensham coal-seam, which is highly charged with gas, and has been the cause of many accidents.

We add to the table in the foregoing extract, a recent incomplete return of the numbers of miners that have perished in the Durham and Northumberland coal mines in the last 42 years.

			Total deaths..	
From 1803 to 1821.	From explosion,	105	229	
	Inundated by water,	75		
	Choke damp,	9		
	Boiler bursting and other causes,	40		
1821 to 1843	From explosions,	732	821	About 990 cases of death.
	Falling stone, choke damp and other causes,	89		
1844 to 1845	Explosions, in two cases only, exclusive of other accidents,		134	
Total killed in 42 years in one district, besides numerous cases which have been omitted,			1184	

This appalling account of loss of life in this class of working men has, it is said, led among other causes to the association of colliers in the north of England, called "the Union," which lately comprised 60,000 persons.

This association, it appears, has other objects besides those contemplated by the Belgian provident institutions, or the "caisses de secours" of the French mines. One object aimed at is the facility it affords for enabling large bodies of operatives to strike for rise of wages, &c., or to consolidate the interests of an important and numerous class in the community.

It is asserted that there is not a colliery in the kingdom in which the men are not daily and hourly exposed to similar fatal accidents as are recorded above, which cannot be wondered at, considering the bad ventilation, and the extent of the underground operations, where in some mines sixty or seventy miles of passages have been cut.

Dr. Barham has communicated an article on "the accidents and diseases of miners," more especially directed towards those of Cornwall. He institutes an interesting comparison between the number of deaths in the Cor-

nish mines of copper and tin, and those of the coal districts. The chances of violent deaths in the latter greatly preponderate.

Thus, there were in the Tyne and Wear district, in the 40 years from 1800 to 1840, 1480 deaths from accidents, out of a mining population of 21,000 persons, men and boys, of whom five eighths worked underground.

Out of the 1480 deaths in the collieries, 1325 deaths, or nine-tenths of the whole, were caused by explosions or inundations—accidents to which Cornish mines are rarely subjected.

From official returns given by the Register-general, we are furnished with materials for comparing the mortality among miners with that in other classes of the community. By the census of 1841, the number of males, of twenty years and upwards, employed in the coal mines, as well as those of salt and the metals, was 124,667. Among these, the violent deaths registered in the year 1840 were 498. The only employment which was equally fatal was that of the navy and merchant service. The elative proportions, of deaths in an equal number, are as follows:

In the navy and merchant service, - -	4006
In the mines, - - - - -	3939
In the agricultural population of England, - -	1221*

Frightful as is the foregoing statement of the mortality in the northern coal-field mines, we derive some consolation from perceiving that it falls very short of that in the Belgian coal-field. The results are interesting.

General Cases. In Belgium, out of 20,000 miners, the total number of deaths was 1710 in twenty years, prior to 1841, averaging 85.5 per annum, or thirty to every one thousand miners employed, annually.

In the Durham and Northumberland coal-field the total of deaths in the mines was 990 in the twenty-four years prior to 1846, averaging 41.28 annually, in 21,000 miners, or 19.65 to every 1000 annually.

To render the comparison more exact, we find that the number of deaths in Belgium, proportionate to 21,000 miners, (out of 28,000) is 64.12 per annum.

The Durham and Northumberland coal-field, average of 24 years prior to 1846, 41.28 per annum. Do., average of 20 years prior to 1837, 34.60 per annum.

Thus the number of general cases of death, in a corresponding number of miners, is 55 per cent. greater in Belgium than in the English northern coal-field. When, however, we analyze the causes of these deaths, we observe that the proportions are reversed, and the fatal cases of *fire-damp* are far greater in the Newcastle than in the Belgian coal-field.

Explosions.—Belgium, 503 killed out of 28,000 miners, or 377 out of 21,000, average 18.85 per annum in 20 years.

Northern coal-field, out of 28,000 miners, or 866 out of 21,000, average 36.09 per annum in 24 years.

The mortality by fire-damp being greater in the English coal-field by 31 per cent. than in that of Belgium; or thus, annual deaths by explosions in the Belgian coal-mines, 0.89 out of every 1000 persons employed. In the Newcastle coal-field. 1.72 out of every 1000 persons employed.

Our data is somewhat too scanty to pursue these comparisons far. A statement of the number of miners killed, from various causes, in fifteen years in the basin of the Loire, in France, shows the deaths to be in the proportion of 1 in 100 persons employed. This ratio, if correct, is enormous. That of Belgium averages 1 in 327. The Newcastle coal-field, 1 in 508.

* Mining Journal, January 1, 1841.

Forest of Dean.—Royal Commission of Inquiry into mines.—In 1842, ample reports were made by the chief commissioner of the Gloucestershire mining district. He says that this woodland and mining region, although comprising an area of only 22,000 acres, is so much isolated in its character and local customs, that it presents a field of more than common interest.

The employment of females in the mines and collieries is happily almost unknown in the forest. Boys, however, and those often of a very early age, are employed in considerable numbers, as the thinness of the seams of coal requires the labour of mere children, from their very limited height.

From the evidence adduced in the commissioners' report, it is proved in some of the forest mines, that the subterranean roadways or passages are so small, that even the youngest children cannot move along them without crawling on their hands and feet; in which unnatural and constrained position they drag the loaded carriages or *hods* after them. And yet, as it is impossible, by any outlay compatible with a profitable return, to render such coal mines fit for human beings to work in, they never will be placed in such a condition. Consequently, they never can be worked without inflicting great and irreparable injury on the health of children.

From the peril arising from the destructive influences of malaria and inflammable gases, these mines seem, in a great degree, happily free; and the accidents from explosions are of rare occurrence. The excellent attention given to the system of ventilation, adopted in the Forest collieries, in fact, affords a very general protection from the fatal effects also of carbonic acid gas, or choke-damp.

Staffordshire.—Five lives were lost by an explosion in the Yew-tree colliery, Sedgely, 23d March, 1847.

June 2nd, 1847, eight men and three horses were killed by an explosion of carburetted hydrogen, at Gerard's Bridge colliery, near St. Helen's. In the same month, by an explosion, in Croft Pit, near Whitehaven, four lives were lost. In the same month were nine persons killed by explosion at Kirkless Hall colliery, about two miles from Wigan; besides which there were eight or ten others who were not expected to recover, and about twelve others less seriously injured. Also in the same month, near Wigan, two persons killed, and at Felling colliery, near Gateshead, six miners killed by explosion of fire-damp.

Yorkshire coal-field, XX.—15 persons lost their lives by fire-damp, Nov., 1841, at Barnsley. At Huddersfield, three explosions in 1841. On the 5th of March, 1847, an explosion of carburetted hydrogen took place in the Great Ardsley main colliery, near Barnsley; 95 men were working in the pit at the time, 66 of whom were instantly killed, several died subsequently, and only 10 escaped unhurt.

At Beeston, near Leeds, 17th May, 1847, an explosion led to the death of nine miners.

Lancashire coal-field, XVIII.—Haydock colliery, near Newton.—On the 5th Nov., 1845, an explosion took place, whereby nine persons were killed, and ten others so dreadfully mutilated, as to be unable to survive, with the exception of one.

In the Moyston colliery, ten lives were lost and seven wounded by fire-damp, in 1840, and six persons burned and five hurt in May, 1846.

An explosion from fire-damp in a colliery near Preston took place on the 24th of November, 1846, and on the same day another occurred at Coppell colliery, Standish. Twelve lives were sacrificed in these two cases.

In the same month, by an explosion at Chorley, eight persons were instantaneously killed.

SCOTLAND.

The ordinary casualties of mining occupations prevail here; but that arising from fire-damp does not appear to be so common.

Two explosions took place in 1845, in the Victoria colliery, near Nitshill, Glasgow, but without loss of life.

Ameliorations in the habits and condition of the mining population have taken place, within a few years. Amongst these, none, perhaps, is more important than the prevention of the employment of females in the coal mines, both of Scotland and in some English districts. At the time of the passing of Lord Ashley's Act, in 1842, there were no less than 2400 females in the coal pits of Scotland; seven hundred women in those around Wigan; many in Staffordshire, &c.

SOUTH WALES.

It is ascertained that the loss of life by fire-damp is not less frequent, although on a smaller scale in this coal-field, than in the highly bituminous coal basins of the north of England. Those which occur are in great measure limited to the bituminous portion of the Welsh basin. One of the most important of these accidents was an explosion in the Duffryn colliery whereby 29 miners were killed, on the 2d August, 1845. Minor cases, of the death of from two to ten persons, are less rare, and scarcely a week passes without a case of explosion.

In January, 1844, twelve persons were killed by this cause, at Dinas colliery, and several accidents from the fire-damp took place in other collieries. Three miners were destroyed at Nantyglo, in July of that year. In 1845, a good many accidents occurred, by explosions: at Patricroft, at Swansea, at Mynydd Newydd colliery, four deaths. In May, 1846, a severe case of explosion at the Risca colliery, and in the following month, eight persons were burned at Homfray's colliery, Tredegar.

The employment of females in the mines is or was prevalent in South Wales, but it is hoped the degrading practice is diminished.*

Benefit societies, for the relief of sick and wounded miners, or for their families, are numerous throughout the mining regions, and are productive of considerable good.

CONDITION OF THE MINING POPULATION OF GREAT BRITAIN.

This has been the subject of investigation for some years, and annual reports have been made to government. Difficulties, abuses, and grievances, under which the working miners and their families suffered, have been diligently investigated and pointed out, and remedies have been suggested and acted upon. We cannot here enter into these details. It is evident that remarkable differences in the habits, morals, and comfort of the same classes existed in different mining regions of Great Britain. The causes of these discrepancies or contrasts have been traced to their sources, and placed before the public. The general social condition of this class of population, we have every reason to know, has been greatly ameliorated by means of these investigations.

Some colliery districts, it is well known, have always maintained a more moral, a more respectable and intelligent population, than others. We have no means of classifying these, even were it desirable to do so. Some have been more prominent than others, as we have shown in relation to the Dud-

* Royal mining commission of inquiry into mines.

ley coal-field, and formerly some of those in Scotland; but in all, we have the satisfaction of stating, great improvements have taken place, of late years.

Thus, we read, in a recent article, that "not a little of the success of the Coalbrookdale coal and iron works, must be attributed to the great attention paid to the religious and moral training of the workmen, and the care bestowed on their physical condition. Excellent schools are provided for the children, and lecturers are occasionally engaged to instruct the adults. The training and education of the children, the aids for mental improvement, offered with no niggard hand to the operatives—from 3000 to 4000 in number—have rendered the work people of Coalbrookdale a very superior class to those usually employed in mines and forges."*

Education of the youth at the collieries, through the untiring agency of the benevolent proprietors and the exertions of the clergy, is making rapid progress in many districts. At the Low-moor Iron Company's colliery, near Bradford, where, in 1841, only two in ten could read, out of 1100 employed, there were, in September, 1845, out of 494 boys, between ten and eighteen, at work, 411, or 83 per cent., who could read.

Condition of the Mining Population of Great Britain in 1847.—By an act of Parliament, passed in 1842, commissioners were appointed "to inquire into the operations of that act, and into the state of the population in the mining districts." Four reports, between 1844 and 1847, have been presented by these commissioners, under the provisions of what is generally known as Lord Ashley's act, and refer to portions of England, Scotland and Wales. We have extracted freely from a portion of these.

An excellent article on these reports, but more especially on that which relates to Scotland and the north of England, appeared in the North British Review for November, 1847. No apology, we trust, is necessary from us, for introducing a sketch of the article to which we refer, particularly as it supplies some information in which we were otherwise defective.

On the authority alluded to, some facts as to the condition of the colliers in the north are detailed, which might almost appear incredible.

"Whether it may have arisen from the nature of the employment underground, or whatever may have been the original cause, we shall not wait to determine; certain it is that, till about the commencement of the present century, colliers were kept in a state of perpetual bondage, and from the first moment of their existence were considered as belonging to the property which gave them birth. Without the permission of the proprietor, they could not receive employment in any other place. In fact, they were held to be part and parcel of the establishment for carrying on the working of the coal; and if it happened to be let, they were specially described in the lease, and transferred to the lessee, in the same manner as if they had been a number of horses. When the legislature passed measures for the benefit of the community generally, the colliers were expressly exempted from the privileges which such measures conferred. Even in the well-known *Habeas Corpus* act it was declared, '*that this present act is no ways to be extended to colliers and salters.*'

"In 1775, an act of the British parliament was passed, which declared that colliers and salters were to be no longer 'transferable with the collieries and salt-works;' but upon certain conditions, which were then deemed 'reasonable,' they were to be gradually emancipated and set free, and others prevented from coming into such a state of servitude. But the

* London Art Union, 1847.

act of 1775 does not seem to have operated satisfactorily; and in 1799 another act was passed, which completely freed colliers from the bondage in which they had been previously held, and placed them on a footing of equality with the other labourers of the kingdom."

Another evil, of great magnitude, which had long existed in Scotland, and which presented the greatest obstacle to the improvement of the condition of the mining population, was unquestionably the employment of females under ground.

The arrangements were such, that the labour of the man who worked or hewed the coal was wholly unproductive without the assistance of his wife or daughter, whose occupation it was to carry it away; and unless trained to it from their infancy, it was totally impossible for females to engage in such employment.

In a very interesting book, entitled "A General View of the Coal Trade of Scotland," published by Mr. Bald, in 1808, a graphic description of the work performed by a female "coal-bearer" is given. We are compelled to abbreviate the details. "The collier leaves his house for the pit, about eleven o'clock at night, [attended by his sons, if he has any sufficiently old,] when the rest of mankind are retiring to rest. Their first work is to prepare coals, by hewing them down from the wall. In about three hours after, his wife, [attended by her daughters, if she has any sufficiently grown,] sets out for the pit, having previously wrapped her infant child in a blanket, and left it to the care of an old woman, who, for a small gratuity, keeps three or four children at a time, and who, in their mother's absence, feeds them with ale or whiskey, mixed with water. The children who are a little more advanced, are left to the care of a neigbour.

The mother, having thus disposed of her younger children, descends the pit with her older daughters, where each having a basket of a suitable form, lays it down, and into it the large coals are rolled; and such is the weight carried, that it frequently takes two men to lift the burden upon their backs; the girls are loaded according to their strength. The mother sets out first, carrying a lighted candle in her teeth; the girls follow, and in this manner they proceed to the pit-bottom, and with weary steps and slow, ascend the stairs till they arrive at the hill or pit-top, where the coals are laid down for sale; and in this manner they go on for eight or ten hours, almost without resting.

We have seen a woman, during the space of time above-mentioned, take on a load of at least 170 lbs. avoirdupois; travel with this 150 yards up the slope of the coal below ground; ascend a pit by stairs 117 feet, and travel upon the hill 20 yards more to where the coals are laid down. All this she will perform no less than twenty-four times, as a day's work.

The whole distance, thus loaded, during each, day, was	5016 yards
And the unloaded distance, ...	5016
Total of the daily work, 5¾ miles, or .	10,032 yards.

In those pits which are so deep as to prevent the women from carrying the coals to the surface, the distance which they bring their loads to the pit-bottom may be stated at 280 yards. This journey they will perform thirty times with the weight above-mentioned, in the space of ten hours; so that the journey performed each day, is loaded, 8400 yards; not loaded, 8400 yards. Total length, 16,800 yards, or more than 9½ miles. The perpendicular ascent of the slope of the coal being 700 yards."

This is the testimony of Mr. Bald, who has been for half a century at the head of the mining of Scotland, and who has done more than any other man, not merely to improve the method of working, but to elevate the character of the worker.

We are assured that this is no exaggerated statement. It is utterly impossible for language to convey to a stranger anything like an adequate idea of the immense toil which those poor women had to undergo. It was reckoned nothing extraordinary, at a Lothian colliery, for a woman to carry on her back from 35 to 40 cwt. of coal each day, a distance of between 300 and 400 yards; the greater part of the road being not higher than 4½ feet, and, in some cases, a considerable portion of it covered with water.

The reviewer, with perfect justice remarks, that it is certainly something very remarkable that, in the vicinity of the most polished city in the kingdom, and for the purpose of supplying it with an important necessary of life, there should have been in existence, until as it were yesterday, one of the most offensive and disgusting systems of slavery that ever disgraced a civilized country!

On the 7th of May, 1842, Lord Ashley, with whom the commission originated, rose in his place in the house of commons, and moved "for leave to bring in a bill to make regulations respecting the age and sex of children and young persons employed in the mines and collieries of the United Kingdom." In introducing the subject, this philanthropic nobleman said—

"It is not possible for any man, whatever be his station, if he have but a heart within his bosom, to read the details of this awful document, without a combined feeling of shame, terror and indignation. But I will endeavour to dwell upon the evil itself, rather than on the parties that might be accused as, in great measure, the authors of it. An enormous mischief is discovered, and an immediate remedy is proposed; and sure I am that if those who have the power will be as ready to abate oppression as those who have suffered will be to forgive the sense of it, we may hope to see the revival of such a good understanding between master and man; between wealth and poverty; between ruler and ruled, as will, under God's good providence, conduce to the restoration of social comfort, and to the permanent security of the empire."

After describing the measure in detail, Lord Ashley concluded in this striking and beautiful language:—

"Is it not enough to announce these things to an assembly of Christian men, and British gentlemen! For twenty millions of money you purchased the liberation of the negro, and it was a blessed deed. You may this night, by a cheap and harmless vote, invigorate the hearts of thousands of *your* country people; enable them to walk erect in newness of life; to enter on the enjoyment of their inherited freedom, and avail themselves, (if they will accept them,) of the opportunities of virtue, of morality, and of religion. These, sir, are the ends which I venture to propose: this is the barbarism that I seek to remove. The house will, I am sure, forgive me for having detained them so long; and still more will they forgive me for venturing to conclude, by imploring them, in the words of holy writ, 'to break off our sins by righteousness, and our iniquities by showing mercy to the poor, if it may be a lengthening of our tranquillity.'"

We have been informed, that during the delivery of Lord Ashley's speech, the House of Commons was a perfect calm—not a whisper was heard. The simple announcement of the injuries inflicted, the sufferings endured, the degradation and ignorance prevailing, made such an impression in the

house that many a stout heart melted, and tears were shed, where seldom tears had been shed before.

The act passed in the autumn of 1842. It has now been five years in operation, and we will venture to affirm that no measure was ever passed which so fully realized all the expectations of its supporters, or so completely refuted all the objections of its opponents.

FRANCE.

Mining Casualties in the Coal Basin of the Loire or St. Etienne.

Years.	Workmen employed.	Number of Workmen. Killed.	Wounded.	Total.	English Tons (of 10,146 met. quin.) Produced.
1817	1,825	18	27	45	382,625
1818	1,915	14	37	51	387,352
1819	1,927	20	16	36	328,200
1820	1,945	20	38	58	374,390
1821	2,038	19	33	52	397,920
1822	1,958	25	26	51	415,131
1823	2,259	32	16	48	445,113
1824	2,514	12	19	31	548,567
1825	2,814	21	21	42	503,341
1826	2,708	26	30	56	552,216
1827	2,738	17	11	28	616,653
1828	2,190	28	11	39	656,490
1829	2,970	46	16	62	614,684
1830	3,029	30	29	59	673,400
1831	3,053	30	10	40	625,486
	36,879	358	340	698	7,521,568
Av. of 15 y'rs	2,458	23.86	22.66	46.52	Av. to each miner 204 an'ly.

Of the foregoing list of casualties occurring in the fifteen years, from 1817 to 1831, the immediate causes were as follows:—

Crushes or falling in of the ground,	299 =	20.	annually.
Inflammable gas or fire damp explosions,	179 =	11.92	"
Falling of rocks, timber, &c.	220 =	14.60	"
	698 =	46.52	"

Proportion of deaths, 1 in 100; proportion of accidents, 1 in 52.

It is remarked that Mondays are the days of the week on which the greater part of the accidents happen.

The casualties recorded above which occurred in a working population averaging during the 15 years only 2458 miners, seem to be very disproportionate to the number employed; being at the rate of 1 in 155, annually. In the foregoing statement the deaths by fire damp at St. Etienne, during this period, form only one fourth of the total number; while the falling in of the ground in the subterranean works has been the principal cause of nearly three fourths of these accidents.* The safety lamp of Sir Humphrey Davy was introduced here in 1825.

In 1845, a scientific commission was formed in France, to inquire into the causes of fire damp in the French mines, and to suggest the best means of preventing them.

Most of the mines in this department possess local *caisses* or funds for

* This preponderance of the number of accidents in the Basin of the Loire, from the falling in of the ground or roof in the subterraneous works, seems to be of local occurrence. In other districts, those arising from explosions of gas are the most disastrous.

the relief of the families of workmen; this resource has often proved inadequate; but the owners of the mines and the inhabitants of the district have generously vied with each other in relieving the families rendered needy by these accidents. The government has also relieved many sufferers.

By a circular of the under-secretary of state, for the public works, addressed to the prefects and engineers of mines, they are directed to furnish, sometime in January of each year, an account of the accidents which may have occurred in the mines and quarries, during the preceding year; distinguishing the number of workmen employed in each department and the number of killed and wounded, the cause, &c.*

We have elsewhere observed that the daily employment of the coal miner was accompanied with far greater risk of life than that of the workman engaged in the extraction of the metallic ores, and consequently that it was the more expedient to provide the means of meeting or alleviating the accumulated casualties of the collier's life. From a statement before us, it appears that, in France, the proportion of coal miners killed or seriously injured, annually, has amounted to one in one hundred and forty-four, while in the mines of metalliferous ores, the proportion is only, on an average, one in four hundred and twenty-five.

We have shown that in the basin of St. Etienne alone six hundred and ninety-eight coal miners have been killed or wounded in the space of fifteen years; that is to say, forty-six per annum; but this represents one-third of the coal production of France. It has been ascertained that the general average of deaths in the coal districts of France, occasioned by mine accidents, is between ninety and one hundred, for an extraction of coal amounting to three millions of tons, about equal to that of Belgium, where the average deaths are as much as one hundred and twelve annually.†

The great sources of the accidents which occasion sudden death in coal mines, are obviously the irruptions of water and the explosions of the fire-damp; the last being the most frequent and active. The fall of rocks, the *eboulements* or crushing, which seem at first sight, to constitute the principal elements of danger, enter only into a fraction of the sum total of disasters. The proportion of killed and wounded by fire-damp in Belgium, between 1821 and 1842, is about 38 per cent. of the total number of accidents.

These distressing occurrences have by no means diminished of late years. On the contrary, they appear to increase in all the coal mining countries of the world, in the ratio of the increased depth to which the workings of the collieries are carried.

On the 23d March, 1847, an explosion took place in one of the coal pits of La Grame, in Alsace. Out of thirty-six workmen who were in the pit at the moment, twenty-four instantly perished, and the other twelve were seriously burned.

An imperial decree, 26th May, 1813, founded, in the department of Ourthe, a *caisse de prévoyance*, in favour of the poor colliers. But this institution, even in the same department, had not taken deep root; at Liege, it did not survive the fall of the empire.

A royal ordinance, 25th June, 1817, established at Rive-de-Gier [Loire,] a common "foresight chest" for the working miners of this basin: the association also had no long duration.

The two institutions, of the empire and the restoration, failed from the same cause. They were unable to resist the times; because they were not

* Annales des Mines, tome vii. 1845. † Géologie appliquée, par M. A. Burat, Paris.

rooted in the economical habits of the workmen. They were almost exclusively benefit societies; the providence of the workman, which ought to have formed the principal characteristic, was there only an accessory.

The generosity of the proprietary had little utility, because they helped the unfortunate *unproductively*. The Belgian societies are not so: the gifts of the mine explorer and the subsidies of the government have resulted in stimulating the clubbing of the workmen, and of doubly interesting them.

The principal mine establishments of France usually possess local *caisses de secours*, in favour of their workmen; but no common association unites together several of these mines. These "chests" are organized and administered somewhat after the manner of those at the Belgian collieries.

Insurance associations multiply throughout France; they protect the assured against the principal disasters which can await him. The philanthropic societies of Paris, of Nantes, and of Mulhouse, contribute much to spread similar institutions and the germs of order and economy, in the working class.

The miners of France are still without public provident societies. It is more difficult to organize such associations in this kingdom than in Belgium; either because the miners are more scattered, or because the dangers are less. But it is not the less useful for the working class to see these imperfect distributions replaced by permanent institutions.

In continuation of the subject, we notice here the progress made to form somewhat similar institutions to those of Belgium. Among others in France, to which we shall refer, is the "relief chest" or fund, "*caisse de secours*," for the benefit of the working miners in the department of Ariége.

In 1842, a report was made by the minister, M. Teste, Secretary of State for the Public Works, to the king of the French, in which a project was submitted to his majesty, for the establishment of a "*caisse de prévoyance*" at the mines of Rancié, in Ariége. The minister remarks, that these institutions, so useful to the whole working class, are especially needed by the miner, who is, by the nature of his employment, exposed to daily danger, and who can with great difficulty, by his own individual economy, assure himself of resources against the casualties to which he is subject.

The administration has long been aware of the influence which these kind of establishments would have over the well-being of this class of workmen.

A decree of the Emperor Napoleon, in 1813, prescribed, for the department of the Ourthe, the formation of a relief chest for the miners of that basin.

A similar institution was created in the department of the Loire, by royal ordinance in 1817.

The advantages which were anticipated from these beneficent projects were not immediately realized. We cannot here act by force. They required the free assent and co-operation both of the proprietary of the mines, and of the operatives or workmen. This indispensable junction of the will of the whole often occasioned serious obstacles. Individual resistances fettered that which was the interest of all to extend.

In Belgium they have been more happy. The workmen in the five subdivisions of the coal territory of that country, have concerted together to organize relief funds and annuities; they have drawn up their statutes in a form which has met the approval of the government, and secured the benefits of its protective influence; and an association is thus firmly established which comprises the various concessionaries and the workmen.

Belgium, in this respect, is in a most favourable position. In France, the works are, in general, more dispersed. With some exceptions, the working miners do not present in France, as with her neighbour, a population concentrated upon certain points; devoted exclusively, from father to son, to working in the mines; and having those habits of fraternity from which results a powerful moral bond.

At the same time, it is but just to say, that several of the mines of France offer examples of provident or relief funds, which have been successfully established.

One of the largest establishments in the kingdom, the iron mines of Rancié, is placed in circumstances where these ameliorations can be immediately realized. These circumstances are detailed to the government by the minister. Although they are of an interesting character, we are compelled to omit them. Finally, he solicits the sanction of the king to the meditated institution, and thereby to confer on it that consistence and firmness which is essential to its well-being.

On the 25th May, 1843, a royal ordinance was issued to create a relief fund, "*caisse de secours*," in favour of the working miners of Rancié; and, by a series of articles, the plan of the institution and of the government, and the duties of the members, are detailed. The relief fund comprehends aid to the sick, the aged, and infirm miners, and affords assistance to the widows and children of deceased workmen. The plan has met with the general approbation of the community for whose benefit it was designed, and the cordial support of the mayors of the eight communes of the valley of Vicdessos; which communes were declared by royal ordinance, in 1833, concessionaries of the said mines of Rancié.*

Existing in the midst of the elements of destruction, the working miners have not been able to escape from superstitious impressions, and, on this head, we find that in mining countries, widely separated from each other, there exists a similar belief, which attributes most of the accidents to local or evil spirits who, in order to defend the subterranean treasures against the encroachments of man, oppose to his progress the waters, the gases, the fallings down, &c. There results a real evil from these superstitions: they afford a pretext for carelessness, already too prevalent among miners, and for neglecting to take the necessary precautions. Accidents are, moreover, multiplied with the extension of the subterranean works; and, while seeing men exposed all their lives to risks so terrible, there is no company or government that remains unmoved or has not sought to prevent them; at first by wise prescriptions, and then to mitigate their effects. The establishment of benefit societies—*caisses de secours*—is one method generally adopted. A fund created by a reserve from the wages of the workmen and other persons employed, and from the eventual profits of the society, is distributed among the wounded, the widows, and the children of those who fall. These funds are administered by a council, presided over by the administrator or manager, and of which the engineer, the cashier, and several master miners delegated by the workmen, form a part. This council regulates the number of pensions and the time which they ought to continue, according to the nature of the accidents and the position of the injured individuals, as to means of subsistence.†

A fact of some interest, when viewed in connection with the subject of these pages, has been elicited by the returns made to the French govern-

* Annales des Mines, 1843, Vol. III. p. 923. † Burat, p. 610.

ment relative to the savings banks of France. It appears that, in 1845, 123,000 workmen of different trades, were depositors in these banks; and that, out of this number, no less than eighty-one thousand were miners.

Considering that the mining population of France is not as 1 to 20 of the working classes, it would appear from these statistics, that miners are here more economical and prudent than any other section of the labouring community.

UNITED STATES OF AMERICA.

Bituminous coal works.—With the exception of the Richmond coal-field there are few works where the subterranean operations are sufficiently extended to render them dangerous from the presence of fire-damp.

In March, 1839, an explosion took place in one of Heth's pits, Chesterfield, Virginia, by which a number of lives were lost.

These mines are from 400 to 700 feet deep, and are almost entirely worked by slave labour.

In 1844, another explosion took place in one of the Black Heath pits, while four Englishmen and eight negroes were in it.

Anthracite Collieries.—Some few of the deepest workings in the Pottsville district have been so far troubled with fire-damp, as to require some caution on the part of the miners. Explosions on a small scale occasionally occur, but we have no very serious cases to record, up to the present time; although it is evident that, as the mines are deepened, the risk and danger increases, and it will require greater circumspection hereafter.

In February, 1847, seven lives were lost by an explosion in Spencer's mine near Pottsville.

Benefit clubs and associations for relief in times of sickness prevail in this mining district, after the English method.

Miners' Asylum.—A project was suggested through the columns of the Miners' Journal of Pottsville, in 1840, for the relief and support of such miners as became disabled by accident from pursuing their dangerous avocation. It contemplated the raising of a fund sufficient to erect a building for the reception of sick and wounded miners, and an annual contribution towards its endowment. The plan was originated in charitable and philanthropic motives, but was somewhat crude in its conception; and, as it proposed to be maintained from resources derived from a tax on the purchasers of coal, consumed at a distance and in great measure by other states, while the mining community was to be relieved from all the burthen, it was not likely to secure public favour. It has been thoroughly proved that no project of this sort is successful in its results, in which the expenses are not, to a certain extent, defrayed by the miners themselves; or, as in Belgium and in many instances in England, supported at the joint expense of the owners and the workmen, and carried on under their joint control and supervision.

No plan has as yet been decided upon, 1848.

In Pottsville, the great centre of the mining population of the anthracite region of Pennsylvania, we may infer that the moral condition of the working class, particularly of the rising generation, is carefully looked after, from the establishment of so many schools for their education. It was ascertained, in 1842, that there were then in Pottsville the following schools and number of pupils then receiving instruction in that place, which but a very few years ago was a barren and profitless wilderness.

	Pupils.	Teachers.
Sunday schools, - - - -	1137	150
Eight public schools, - -	472	8
Private schools, - - - -	479	15

Out of a population then amounting to but 4500 souls, brought together from various parts of the globe, we thus find eleven hundred children receiving the benefits of a sabbath school education, and nearly one thousand children who attended the public and private schools, during the week days.*

Mauch Chunk, Anthracite District.—We have been favoured by the kindness of the Lehigh Coal Company with the following synopsis of the mining and general population, the schools of instruction and places of worship within the limits of the Company's coal operations, in the year 1846, all of which had scarcely commenced to exist twenty years ago.

The mining accidents are not very frequent: they have probably averaged three lives lost a year.

Details.	Summit Mine and vicinity.	Farm and Old Tunnel.	Nesquehoning mines.	Mauch Chunk.	Total.
Total mining population, - - - - - -	1,350	90	756	300	2,496
Working men employed at the mines, - - -	650	30	300	100	1,080
Sabbath schools, English, - - - - - -	2		1	3	6
" " Welsh, - - - - - -	1				1
Common or public schools, - - - - - -	4		2	4	10
Methodist Church, - - - - - - -				1	1
Roman Catholic Churches, - - - - - -	1		1		2
Presbyterian Churches, - - - - - - -	1			1	2
Episcopal Church, - - - - - - -			1	1	1
Division of Sons of Temperance, - - - -				1	2
Division of Odd Fellows, - - - - - -				1	1
Beneficial Society, - - - - - - -				1	1

And a population, at Mauch Chunk, of 1500 persons dependent on the coal operations, exclusive of those engaged in transportation and the coal trade, &c. here and elsewhere.

We have brought together in the foregoing pages a small portion of the details which, were we writing on no other subject than the moral and physical condition of the working population in the coal districts of various countries, would be very inadequate to our purpose. But our scope is too limited to admit of further extension in this branch of inquiry, however interesting it may be.

In the sketch before us, we have had a two-fold object: first, of glancing at the innumerable casualties attending the miner's life; at his moral and physical disabilities: second, at the means which have been taken by the philanthropic and the benevolent, in conjunction with his own exertions and the triumphant assistance of education, to ameliorate his condition, to compensate as far as possible for unavoidable privations, and to elevate him above a position which, as we have seen, is too frequently one of extreme degradation. It will be regarded, with pleasure, that the efforts made in his behalf by the good and the influential of all these countries have not been

* Miners' Journal.

profitless; and that the impulse, thus given at the commencement of the work, has been seconded by the majority of the workers themselves. This is the true, the rightful working of the system; and the beneficial results already appear on every hand, where so many interests co-operate to alleviate the wretched, to inform the ignorant, to elevate the debased, to reform the improvident, to encourage the industrious, the successful issue appears inevitable; it is indeed, already manifested in the improved condition of those, to whom these benevolent exertions have been directed.

To those who have perused the sickening details recorded in the Report of the Midland Mining Commission, and the almost incredible evidence of the condition of the South Staffordshire mining population, so late as 1842, the prospect of any amendment of such a lamentable state of society must be welcome. To those, again, who were apprised, for the first time, of the degrading and demoralizing employment of thousands of females in the coal mines of England and Wales, and moral Scotland, the interposition of the legislature, sanctioned by the approbation of the wise and humane throughout the empire, must afford cause for rejoicing in the progress of a reform so needful. The beneficial effects of education, and of the Sunday school system, of which we have ample evidence, both in the New and the Old World, have had the most happy influence on the industrial classes, and on none more than the youth of the mining communities. The noble example set by the Belgian government in supporting the provident associations of the miners in that country, will be followed by other European states, and is already in progress in France.

NORTH AMERICA,

COMPRISING

1. THE UNITED STATES.
2. BRITISH AMERICA.
3. RUSSIAN AMERICA.
4. OREGON TERRITORY.
5. UPPER CALIFORNIA.
6. NEW MEXICO.
7. MEXICO.
8. TEXAS.

UNITED STATES OF AMERICA.

AREA, exclusive of Texas and Oregon, estimated at 2,300,000 square miles.

	Population.	*Slaves.*
Population in 1840,	17,063,353	
Of which there were Slaves,		2,487,355
Population in 1845,*	19,914,362	

Weights and Measures.

Ordinary estimate of Bituminous Coal—28 bushels = 1 ton of 2240 lbs.
Occasionally it has been customary to allow 30 do. = 1 do.
But, we also find it stated, in the west, at $26\frac{1}{4}$ do. = 1 do.

At Richmond coal pits the common measure is 5 pecks to a bushel.

The same coal put on board at Richmond, is 4 pecks to the bushel.

The Richmond coal bushel at the pit's mouth, is said to weigh 90 lbs. = 24 bushels and 80 lbs. to 1 ton.

The four peck bushel weighs 72 lbs., and the ton contains 31 bushels and 8 lbs.

In the south, bituminous coal is sold by the barrel, weighing $172\frac{1}{3}$ lbs. There are, therefore, 13 barrels to 1 ton of coal.

In the anthracite trade the prevailing standard is by the ton of 2240 lbs.

Occasionally, in retailing, the ton is only 2000 lbs.; it is so quoted at New York, Cleveland, &c.

On the State Canal, and the Tide-water Canal, the toll is levied per 1000 lbs. of coal.

Foreign bituminous coals are, or were, commonly sold by the chaldron of 36 bushels. A chaldron of these coals weighs $25\frac{1}{2}$ cwt.

A bushel, measured when dry, weighs 84 or 85 lbs.; but in Pennsylvania, in Ohio, at Cleveland, and several other places, the bushel is equivalent to 80 lbs.

What used to be sold under the denomination of a Newcastle chaldron, weighed 2 tons and 13 cwt.

The Nova Scotia chaldron is $1\frac{1}{2}$ tons, or 3360 lbs. of 42 bushels; but the measurement yields 48 bushels.

The Boston retail chaldron is commonly 2500 lbs., but sometimes 2700 lbs.

The tariff duty was levied on the chaldron of 2880 lbs. or 36 bushels of 80 lbs. each.

* American Almanac, 1847.

A cord of wood 8 × 4 × 4 feet = 128 cubic feet.
The Austrian corde of wood is 88¼ do.
40 feet of round timber } = 1 ton.
50 feet of hewn timber }
1 pound = 0 kilogr. 4535.
1 barrel of flour = 98 do. 391.
1 bushel = 35 lit. 236.
1 yard = 0 mèt. 9144.
1 Mexican or Texas *Vara*, represents 33⅓ English inches, = 0 mèt. 847 French.

United States Currency.

1 dollar = 100 cents, = 4*s*. 1½*d*. = 5*fr*. 35*c*. [4*s*. 16*dec*.]
1 cent, = 0*fr*. 5*c*. 35.
Par value of 1 United States dollar in London, 47½ pence.
£1 sterling = $4.84 nearly, = 25*fr*. 89 cents, to 25.76, legal value.
1 shilling, English, $0.24*c*.20.
1 crown " 1.21.
The value of the 5 franc piece is fixed by Congress at 93 cents.

Spanish American Currency.

1 hard dollar, = 100 cents, = 4*s*. 2*d*. = 8 reales.

Previous to the 31st July, 1834, the American eagle contained 270 grains of standard gold, viz. 247 grains pure, and 23 grains alloy. By the Act of Congress of that date, the weight of the eagle was reduced to 258 grains, of which 232 are pure gold, and 26 alloy. In consequence of this alteration, the sovereign, or pound sterling, that was formerly worth $4.57 cents, is now worth $4.83.8 cents.* Under the present American system, it is believed that gold is over-valued from 1¼ to 1½ per cent.

Money.

"The mode still adhered to by many of quoting exchange between the United States and London, is both *obscure* and *absurd;* as the premium or discount is founded upon the *false*, or nominal *par* of $4.44, instead of the true par of $4.86." In the calculation of duties at the United States custom-houses, since 14th July, 1832, the value of the pound sterling is fixed by law at $4.84.

The banks receive and pay out sovereigns at $4.85.†

Among the "Documens sur le Commerce exterieur," of France, published in June, 1843, occurs the following passage relative to the pound sterling. "In 1842, an Act of Congress, of the 27th July, fixed the legal value of the pound sterling at $4.84, [= 25*fr*. 89*cts*.] for the conversion, in American currency, of prices to foreign agents, and for payments into the American treasury. Previously, this value was $4.44 [= 23*fr*. 75*c*.] a rate that the American treasury had substituted, in 1840, for that of $4.80, [= 25*fr*. 68*c*.] established by law of the 2d March, 1799."‡

* Bicknell's Gold Chart. Also, Moore's "Philadelphia Price Current."
† New York Journal of Commerce, Oct. 1839.
‡ In continuation of this subject, we insert the following illustrative note:

A Commercial Absurdity.—The current quotations, as 7, 8, or 9 per cent. premium for exchange on England, which we see in the newspapers, do not mean a premium on the par value of the pound sterling, but on a fictitious valuation of the pound which prevailed

The weight of the Spanish and American dollar is 416 grains troy.
100 dollars, therefore, are equal to 211,742 Sicca rupees.
or, deducting the duty, to 207,508 Sicca rupees.*

The dollar is a legal tender, at the price of 4*s.* 4*d.* English currency, in the East Indies.

Value of Foreign Moneys.

AS TAKEN AT THE CUSTOM-HOUSE IN NEW YORK, IN 1846.†

Barcelona and Catalonia livres,	$0.35½
Brabeint florin,	0.34
Bremen dollar,	0.78
Bengal, Calcutta and Bombay sicca rupee,	0.50
China tale,	1.48
Crowns of Tuscany,	1.05
Denmark Rix dollar,	1.00
Ducat of Naples,	0.80
Dutch florins or guilders,	0.48
English pound sterling, fixed by law,	4.84
French francs,	0.18¾
" livre,	0.18½
" five franc piece,	0.93
Genoa livre,	0.18¾
Halifax pound,	4.00
Hamburg Rix dollar,	1.00
Leghorn dollar,	0.90¾
Louis d'or, or Rix dollar of Bremen,	0.78½
Portugal milreas,	1.24
Russian rouble,	0.10½
Spanish rial of plate,	0.10
" of vellon,	0.05
Saxon dollar,	0.69

Systems of Weights and Measures.

IN GENERAL USE, IN RELATION TO COAL, IN THE UNITED STATES OF AMERICA.

In our progress through this section of our work, it has been our endeavour, when reporting on given amounts of coal, whether anthracite or bituminous, to render them in one uniform standard. We have effected this, at the cost of much extra labour, and have brought out the results in a common denomination—that of WEIGHT. We have done so under the conviction that, sooner or later, that principle must be universally complied

in this country a century ago, when the States were colonies. For example, the pound sterling, or gold sovereign, is to-day worth $4.85 in Wall street, which is about the par value as established by law of Congress. A thousand of them would be worth $4850. The current rate of exchange on England in Wall street is now about nine per cent. premium, as the phrase is, for bills payable in London or Liverpool. But this premium is not on $4.85, the par value of the pound, nor yet on the pound sterling, but it is on $4.44, the old colonial value of the pound. For example, A. B. buys a bill of exchange for £1000 on England, from C. D., at 9 per cent. premium; he pays $4844.44 for it. Suppose he gave a thousand sovereigns for it, at current value, there would be a balance in his favor, so that, in reality, the rate of exchange on England, instead of being nine per cent. against us, is in our favor, because bills can be obtained cheaper than gold. Of course, then, there is no object in sending gold to England. Hence the absurdity of this ideal mode of dealing in exchange on England, which is still kept up by our merchants and newspapers.

* Hand Book of India, 1844, p 65.

† Williams's Statistical Companion, 1846.

with; whatever may be the present prevailing provincial customs, or the ordinary usages of trade.

Whether 2240 be the most scientific or appropriate number of pounds to constitute one ton, or otherwise, it certainly possesses the convenience of general adoption, in the principal coal-producing countries of the world, in our times; and of being employed by the great maritime nations, among which Great Britain and the United States stand pre-eminent.

In this country, there can be no sufficient reason assigned why bituminous coal should almost invariably be sold in bulk—that is to say, by *measure*—and anthracite by *weight;* or that the former should be calculated, in the eastern ports, by the chaldron; in the southern by the barrel; at the mines by the bushel: and, although much more rarely, by the European chaldron or the ton:—which ton is generally 2240 lbs. weight at the place of production, and 2000 lbs. at the place of consumption; especially in the eastern ports.

Without altogether discarding the old denominations, in our returns, we have, at least, accompanied them by other tables, representing an uniform standard of weight. We have not limited the process to American returns, but have applied it to every country. In relation to the United States, we have done so the more readily, because we hoped, thereby, to be instrumental in terminating the highly objectionable system of buying and selling a mineral substance like coal by measure; whether that measure be a peck, a bushel, a barrel, or a chaldron; for we have all these varieties, and all are equally indefinite, equally liable to abuse, and equally disadvantageous to both buyer and seller.

In Europe,—in all the great coal producing and coal buying countries,—it has long ago been demonstrated, after very full investigation in all its bearings, that there exists no fair and equitable system, suited alike to the buyer and the seller, the miner, the producer, the transporter and the consumer, except that of *weight*.

Local usages and peculiarities are always sources of embarrassment in commercial transactions. We feel their influence in this country daily.

In Pennsylvania, for instance. In the tariff of tolls on bituminous coal and anthracite,—fixed officially and annually, and to be received on the State and Tide-water canals and railroads,—the article, mineral coal, is charged per 1000 lbs. weight. Now, as in Pennsylvania there is no such weight recognized by the producer or by the trade, for the reason already assigned, that the bituminous coal is sold by measure and not by weight, this new denomination, applied to the article on its transit merely, is obviously a source of inconvenience to more parties than one.

So also in relation to anthracite; for as all which is transported on these canals and railroads is mined by the customary ton, of 2240 lbs.; conveyed to the landings by the ton; freighted by the ton, and are bought and sold by the same weight: the departure from a universal practice of the trade by the interposition of the 1000 lbs. standard, instead of the genuine ton, not only occasions unnecessary trouble, both to the payers and the collectors of toll, but interposes an uncalled for difficulty in one branch of the trade.

Neither is the rule so general as to demand this interposition, on the score of conformity; for instance, the coal which has descended the Tide-water canal, and has there paid toll per the 1000 lbs. weight, on passing into the Delaware and Chesapeake Canal, pays its toll on the ton of 2240 lbs.

Again, in relation to the movement of coal in neighbouring states, we may remark on the want of uniformity in the system of weights, which cir-

cumstance interferes with the means of acquiring correct statistical information. Thus, the bituminous and anthracite coals which pass down the Schuylkill navigation, in Pennsylvania, are returned by the large ton, while all that pass over the New York canal is returned by the small ton, of 240 lbs. less; and yet the same coal was imported into the state by a different scale of measure,—both that which was shipped at Cleveland or Erie, for Buffalo, or that which came from Pennsylvania by the Tioga railroad.

In Pennsylvania, the Union Canal,* the Schuylkill Navigation, and the Lehigh Navigation, as well as the Delaware and Chesapeake Canal, levy their tolls, and arrange their freights, by the standard ton adopted by the trade: thus employing a different system to that used on the state works.

We will proceed to point out some of the extraordinary discrepancies which prevail in relation to the coal trade; and which, considering we have heard for years past that great attention has been paid at Washington to the establishment of a national system of weights and measures, our readers would not suspect was still remaining in full operation.

Towards the commencement of the coal trade in Pennsylvania, even anthracite was calculated by the bushel. In the vicinity of Pottsville and Wilkesbarre, in those times, leases of mines were granted, the lessee in the former place paying two cents a bushel.†

In some parts of the bituminous coal-field, thirty bushels have been supposed to be equivalent to a ton in weight; in others twenty-eight bushels for gross weight and twenty-five bushels for minimum weight; and we have also heard of twenty-six bushels as representing the ton. For a long time, the usages of the trade, as regards anthracite, assigned twenty-eight bushels as the equivalent of one ton of Lehigh coal, thirty bushels of Schuylkill, and thirty-three bushels of Lackawanna coal. It is needless to point out the utter worthlessness of a system, if system it can be called, so vague, so utterly incorrect and unphilosophical; a practice which operated, so long as it was pursued, equally to the prejudice of the producer and consumer. Yet, it will scarcely be credited, the early returns, during several years, of Lehigh anthracite, were made in bushels.‡

There are numberless and insuperable obstacles to making weight and quantity synonymous terms. In point of fact, there is so much guess work: so much uncertainty, in assigning a standard of weight against a given bulk—which bulk is, of itself, entirely unsettled in real practice, that the consequence, not unfrequently, is that bituminous coal, in the large way, is not really measured at all. The present custom observed is this: Contracts for the coal which descends the Pennsylvania State Canals, are generally made by the ton of 2000 lbs. weight: considered equivalent to twenty-five bushels, each bushel being estimated to weigh 80 lbs. But what is termed the gross ton of twenty-eight bushels, which is supposed to represent the 2240 lbs., is in as frequent use; one being as often used by the shippers from the Alleghany mines as the other.

On the western rivers twenty-eight bushels represent a ton. On the Union Canal, of Pennsylvania, the liberal allowance of thirty bushels to each legal ton is made and accounted for. Yet, in this case, the coal conveyed on the Union Canal is specifically heavier than that of the western rivers, in the proportion of 1.350 to 1.230 spec. grav. The official returns to Congress

*** The returns of bituminous coal passing on the Union Canal, used sometimes to be made in bushels and sometimes in pounds.**

† Pamphlet on the Coal and Iron business, Poughkeepsie, 1828.

‡ Dr. James's History of Pennsylvania Anthracite, Memoirs of the Historical Society of Philadelphia, vol. 1, 1826.

comprehend all bituminous coals throughout the Union, be their specific gravities what they may, at 80 lbs. to the bushel, and twenty-eight bushels to the ton. In Michigan, the coal business is conducted by the bushel measure.

At the coal pits at Chesterfield, near Richmond, Virginia, the coal trade adopted as the standard, five pecks to the bushel; weighing ninety pounds. Consequently each ton of 2240 lbs. actually contains only twenty-four bushels and 80 lbs. over. This measurement, it must be stated, solely applies to coal at the pit's mouth. At the terminus of the railroad, twelve miles from the mines, another system commences. Here, at Richmond, where the coal is shipped, the orthodox bushel is four pecks. This bushel, therefore, weighs 72 lbs., and the ton is now represented by thirty-one bushels and eight pounds over, instead of twenty-four bushels; notwithstanding which the sales in Boston and New York are made by the chaldron of thirty-six bushels, or by the ton of twenty-eight bushels. At Baltimore, twenty-eight bushels.*

In the southern ports, in Pensacola, Mobile, and New Orleans, another and peculiar standard prevails for the sale of bituminous coals; and we find that an indeterminate measure of capacity, called a barrel, prevails. Thirteen of these barrels constitute one ton; each barrel, whatever be the specific gravity of the coal, being calculated to hold a quantity which corresponds with two and a half bushels. This coal was purchased at the mines by the bushel.

With regard to the customs of the trade in the eastern ports: in Boston, foreign bituminous coal is imported and sold by the chaldron; American bituminous coal is generally sold by the bushel; and anthracite is purchased at the rate of 2240 lbs., and retailed at 2000 lbs. the ton. Sometimes the returns are given in tons, sometimes in bushels, sometimes in chaldrons, and one denomination being occasionally mistaken for another, we need not wonder at the singular discrepancies in the published statements of the coal trade there. In Philadelphia, anthracite, both wholesale and retail, is always sold by the legal ton of 2240 lbs. In New York and Boston, the ton is only 2000 lbs., thus gaining six tons on every cargo. On the Reading Railroad a ton of coal is 2240 lbs., but a ton of merchandize is only 2000 lbs.†

Nova Scotia coal is imported, in some quantity, into Boston; always by the chaldron. But what constitutes a chaldron seems a matter of somewhat arbitrary character. It sometimes is fixed at 3000 lbs. weight; sometimes at 2928 lbs.; but most frequently at 3360 lbs., or one ton and a half. The tariff duty is customarily levied on the chaldron of 2880 lbs., or thirty-six bushels; while the retailer sells a chaldron, which is sometimes 2500 lbs. and sometimes 2700 lbs. weight. The Nova Scotia chaldron of 1½ ton, should contain forty-two bushels, of 80 lbs. each; but the custom of the trade, we are informed, raises the admeasurement to forty-eight bushels. In like manner, the ton is rated at thirty-six bushels, instead of twenty-eight.

Amidst all the intricacies of these returns and dealings, it is very difficult to get at the real quantity and prices of foreign imported coals; as the number of chaldrons purchased at the place of production, materially differs from that on which duty is paid, and from that which is sold to or by the retailer.

The registration of imports of Virginia coal in Boston and New York, is by the number of bushels only. At Sydney and Pictou, the mine or colliery

* Baltimore Report, Nov. 16, 1843.

† Reports of the Reading Railroad Company, Jan. 13, 1845, p. 15, and subsequently.

measure is thirty-six bushels to the ton, even measure, or twenty-four bushels heaped measure.

While on this subject it may not be altogether out of place to note that complaints have been made in Pennsylvania respecting the irregulariy prevailing in relation to the weights of other substances besides coal. We have recently observed an article in a Philadelphia paper to the following effect: "It is a singular fact, that our measures for grain are larger than those of New York, Boston, or Baltimore. This deviation from uniformity is greatly complained of by our country dealers and farmers, who ship to Philadelphia, from Maryland, Delaware, and Virginia. A very large quantity of grain is shipped from those states to New York and other ports, which would come here, were it not for the inconveniences arising from the falling short of the measure. Some years since, Congress passed a law providing for uniformity of weights and measures throughout the Union. But we regret to say that our old standard of dry measure still holds its place."*

The same writer alleges that equal ground of complaint exists in relation to the measurement of bark, and the same difficulty with respect to the retail measure of charcoal, in Philadelphia, has been lately settled by municipal legislation.

In the lead region of Missouri the present standard of weight appears to be on the 1000 lb. weight, as in Wisconsin and Iowa. Formerly, the custom prevailed of 108 lbs. to 1 cwt., or 2160 pounds to the ton.

In Pennsylvania, the weight of a ton of iron is local and arbitrary. Thus, we are informed by an experienced iron master, of Centre county, the number of pounds usually assigned as a ton vary according to the following scale:

Iron Ore,	Sometimes taken at	2240 lbs.
	and sometimes at	2480
Manufactured Iron,	Pig Iron universally	2240
	Blooms	24-0
	Bar Iron	2000

In the tariffs of the United States customs, in every case, the ton is required to be of the weight of 2240 lbs.

Among many other irregular or uncertain customs of local weights and measures, we extract the following from our notes.

In Kentucky, corn is measured by the barrel, which is five bushels of shelled corn. At New Orleans, a barrel of corn is a flour barrel full of ears. At Chicago, lime is sold by the barrel, and measured in the smallest sized cask of that name that will pass muster. A barrel of flour is seven quarters of a gross hundred, (112 lbs.) which is the reason of its being the odd measure of 196 lbs. A bbl. of tar is 20 gal., while a bbl. of gunpowder is only a small keg holding 25 lbs., and of cotton, a *bale* is 400 lbs., no matter in what sized bundles it may be sent to market.

Ere we terminate this article, we will advert to two or three facts that have come to our knowledge respecting the uncertainty of any standard of measurement, after long experience, that can be adopted as a substitute for weight, in the sale of coals. For instance, 1 bushel of English coal, *measured when dry*, weighs from 84 to 85 pounds. The American bituminous coals are commonly averaged at 80 pounds per bushel. The same English coal, *if measured when wetted*, paradoxical as it may appear, the weight will be found not so great. The fact is proved, conclusively, that in the dry coal the small particles run to fill up the cavities, making the whole almost

* The North American, January 10th, 1845.

solid mass: whereas a bushel of wet coals only closes up the hollow cavities; the fragments clog together, and the whole do not weigh so much as the dry coal of the like admeasurement.

With regard to the increased measure acquired by breaking up coal, it was commonly proved by the trade, that that which in the large or coarse state measured *five bolls* (say tons or chaldrons,) when broken up, fine, in the hold of the ship after delivery on board, measured *nine* bolls.

As to the continuance or toleration of the system of *heaped measure* for coals, we trust that an end will ere long be put to what has, with perfect propriety, been termed "a barbarous custom." A commercial author, Mr. McCulloch, observes that "all articles that may be sold by heaped measure, *ought* to be sold by weight. In Scotland, indeed, the use of heaped measure was abolished *above two hundred years since*." The French, Belgian, Prussian, Austrian, Spanish, Portuguese, and nearly all other European nations, adopt well ascertained weights for the purchase and sale of coal, and not measures of capacity. Throughout Hindostan, coal is always sold by weight. In the Indian countries north of the Nerbudda river, there is no dry measure of capacity, and every thing is, therefore, sold by weight. This appears also to be the case in most of the Nizam's districts, adjoining those of Ahmednugger. The introduction of a system of measure into the Deccan, seems to be of a late date.*

In the English Act of 5 and 6 of Will. IV. 1835, are the following important provisions:

It abolishes all local or customary measures.

It prohibits "the mischievous practice" of *heaped measure*. All bargains, sales, and contracts, made after the passing of this act, by heaped measure, shall be null and void: and every person who shall sell any articles by heaped measure, shall be liable to a penalty not exceeding 40*s*. for every such sale.

From and after the 1st of January, 1836, all *coals*, slack, culm, and cannel, of every description, *shall be sold by weight, and not by measure*, under a penalty of 40*s*. for every such sale.

All articles [except gold, diamonds, &c.] shall be sold by standard *avoirdupois weight*, of 14 lbs. to the stone, and 8 stone to the hundred weight, and of 20 such cwts. to the ton = 2240 lbs.

"The fact, that so monstrous a system should have been persevered in for more than a century, sets the power of habit, in reconciling us to the most pernicious absurdities, in a very striking point of view. Happily, however, the nuisance has been at last abated."†

The United States is the only coal country, of importance, in the world, where the practice remains uncorrected.

The duty on foreign coke and culm, prior to the modification of the tariff in 1846, amounted to 60 per cent., on its wholesale market value—English, at the principal coal shipping ports, in 1846.

That on foreign bituminous coal was from 70 to 90 per cent., on shipping prices abroad, which is, among the highest duties, payable on any imported article, under the operation of the tariff of 1842.‡

A drawback is allowed on foreign coal exported from the United States, in such cases, for instance, where it has been landed and placed in depot,

* Martin's Colonial Statistics. Appendix iv. p. 143.
† McCulloch's Commercial Dictionary, p. 294.
‡ Letter of the Secretary of the Treasury to Congress, Dec. 16, 1844.

for the use of the British steamers. This law was confirmed by the Senate of the United States, in January, 1840.*

American Tariff of Duty on Foreign Coals.

Import duties on foreign bituminous coals brought to the United States. In all cases the duties are collected upon the ton of 2240 lbs.†

	Year.	Duty pr. bushel heaped.	Per Ton of 28 bushels.	Per Chaldron of 36 bushels.	Average selling price at New York, per Chaldron or Ton.	Rate per ct. on value.
		CENTS.				
TARIFF.—4th July . .	1789	2	$0 56	- -	- - -	22
10th August,	1790	3	0 84	- -	- - -	33
2nd May, . .	1792	4½	1 25	$1 65	$19 00 Chaldron.	50
7th June, . .	1794	5	1 40	—	- - -	56
1st July, . .	1812	10	2 80	3 60	- - -	112
By act 27th April, continued to 1824, . .	1815	10	2 80	3 60	20 to 23 Ch.	112
	1816	5	1 40	1 80	12 to 15 Ch.	56
By act 2nd May, continued to 1833, . .	1824	6	1 68	2 16	10 to 11 Ch.	67
Compromise act of . .	1833	5	1 40	1 80	8 to 14 per ton. proposed to be gradually reduced.	56 to 40
August 30th, ...	1842	6¼	1 75	2 70	7 16 per ton. 5 56 do.	70 to 90
Proposed Tariff in . .	1844	6 to 5¼	1 00	1 50	defeated and abandoned.	50
1st December, 1846, .	1846	an advalo equivalent	rem duty to 0 45	of 30 pr ct.	7 00 per ton.	30

The amount of re-exported coal, on which the duty was remitted, was 11,364 tons, in 1845, valued at $35,957.

We have no official return of the amount of American coal annually exported into Canada from the lakes.

The act of Congress, passed July, 1846, rescinded the tariff of 1842, and substituted a modified one, which took place, Dec. 1, 1846.

British Export Duties.‡

On coals shipped from the ports of Great Britain to foreign ports, from the year 1835 to 1842.

To foreign countries in British ships, 10 per cent. *ad valorem.*

To " " in foreign ships, { 4*s.* per ton, for large coal. 2*s.* per ton, small coal and culm.

To British possessions in British ships, free.

These duties were abolished in 1845; no duties received since March, 1845.

There is no *import duty* on American bituminous coals or anthracite, brought into the Canadas, or any part of British America.

As regards Louisiana, by a treasury letter, July 3, 1821, the trade of Louisiana is placed on the same footing as that of the United States of America, by the government of Great Britain.

* Hazard's U. S. Commercial and Statistical Register, 1840. Also Commercial Reciprocity—Hunt's Mag. Vol. x. p. 358 and 526.

† This table is founded on the Report of the Secretary of the Treasury to Congress, Dec. 3, 1845.

‡ Official Documents of Great Britain.

Gross Importations of Foreign Coals,

From Great Britain, British America, and all other places, into the United States, both in American and in foreign vessels, from 1789 to 1847, inclusive, showing their declared value, the tariff, and the amount of duties received thereon; the commercial year ending on the 30th June, annually.

Years.	Bushels.	Tons.	Official Value. Dollars.	Duties Received. Dollars.	Tariff.
1789*	107,810	3,850	- -	- -	2 cts. per bushel.
1795	125,357	4,477	- -	$ 8,338	
1800	330,041	11,787	- -	25,150	5 cts. do.
1805	498,543	17,805	- -	25,810	
1810	392,857	14,030	- -	19,907	
1814	19,367	691	War.	War.	10 cts. do.
1815	98,398	3,514	Peace.	Peace.	
1820†	673,711	24,061	- -	53,685	5 cts. do.
1825	722,255	25,795	108,527		
1830	1,640,295	58,582	204,773	98,417	
1835	1,679,119	59,972	143,461		
1837	- -	153,450	- -		6 cts. do.
1839	- -	181,551	- -		
1840	4,560,287	162,867	387,238	273,610	
1842	- -	141,526	- -		
1843	- -	41,163	116,312		
1844	- -	87,073	236,963		
		- -	- -		
1845	18,267	85,771	224,483	151,021	$1 75 per ton.
1846‡	- -	156,853	378,597	274,492	
1847	- -	148,021	370,985	123,662	30 per ct. ad val.

From this table of gross *importation* have to be deducted, in order to show the actual *consumption*, the annual quantities taken out of storage at the depots for the Atlantic steamers, &c. and re-exported. This re-exported quantity is about one-twenty-fifth part of the entire importation.

There are other statements of the importations of English coal, differing from the foregoing, but we take the following table from the official returns of the British exports. The reduction since 1842, as compared with the seven preceding years, is attributable to the operation of the tariff of that year; the imports from England have not materially changed in the aggregate, and those from Nova Scotia were about the same in 1847 as in 1842. At the same time the importations of English and colonial coal into Boston have increased since the tariff of 1842.

* Statistical Annals of the U. S. of America, by Adam Seybert, M.D., 1818.
† Report of the Secretary of the Treasury, 3d Dec. 1845, and subsequently.
‡ Commercial List of Philadelphia, 1846–7.

Coal.—Balance of Imports and Exports.

Table of British and colonial bituminous coals, culm and coke, received in the United States, chiefly New York and Boston, from 1822 to 1846, deducting the coal re-exported, and showing the *consumption*: in tons of 28 bushels.

	Years.	British and Colonial Tons of 28 Bush.	Value.		Years, ending June 30.	British and Colonial Coals retained in the U. S. Tons.	Coals of Great Britain only, according to the Parliamentary returns. Tons.	Declared Value. Sterling.	Declared Value. Dollars.
Paying Duty 6 cts. per bush.	1822	34,672	$139,790						
	1824	27,314	111,541	Duty 6 cts. per bushel.	1836	108,432	30,220	£17,080	$ 71,052
					1837	153,450	46,574	29,252	121,688
	1826	34,647	145,262		1838	129,083	57,175	27,949	116,267
	1828	32,364	104,292		1839	181,551	52,930	40,013	166,454
					1840	162,867	77,559		
					1841	155,394	52,273		
	1832	72,978	211,017	$1 75 per ton.	1842	141,450	68,407		
					1843	41,163			
	1834	71,626	200,277		1844	87,073	29,282		
					1845	85,776	58,381		
					1846		57,903		173,290
				30 pr. ct.	1847				

Average Prices of Foreign Imported Coals,

At the ports of shipment, according to the official valuations, returned to the United States.

Years.	Per Ton of 2240 lbs. Foreign Coal.	Years.	Average price per ton of 2240 lbs. Foreign Coal.	Wholesale prices at Philadelphia, per ton of Anthracite.
1822	$4 00	1836	$2 27	
1824	4 08	1838	2 40	
1826	4 19	1840	2 37	$5 50
1828	3 21	1841		5 00
1830	3 50	1842	2 68	4 25
1832	2 90	1843	2 83	3 50
1834	2 79	1844	2 72	3 37½
		1845	2 62	3 50
		1846	2 41	4 75

The 4th column shows the average price, at the place of shipment, of all descriptions and qualities of foreign coal, both English and colonial. The colonial coal is shipped at a lower price than the European.

The amount of Nova Scotia and Cape Breton coal imported into Boston during the ten years from 1835 to 1845, was 314,565. In 1845, 33,628 chaldrons of this coal were imported into Boston, or 42,035 tons. In 1846, 26,851 tons only.

Condensed View of the Importation of Foreign Coal into the United States.

The following statement is compiled from both the American and the British parliamentary returns, and, although incomplete, will probably furnish the most approximate view of the actual importation of coal into the United States; in tons of 2240 lbs.

In framing this statement, we have endeavoured to rectify various discrepancies in the returns, but not always satisfactorily.

Years.	British Coal, from the Parliamentary Returns.*	Colonial Coal, from the U. States Returns.	Coals received from all other places.	Gross Importation. Bushels and Chaldrons reduced to	British Coal re-exported for the use of the Steamers.†	Gross Value of Imported Coal.	Average Value per ton, at the Shipping Ports.
	Tons.	Tons.	Tons.	Tons.	Tons.	Dollars.	Dollars.
1801	- -	- -	- -	21,027			
1810	- -	- -	- -	14,031			
1820	average of	10 years	- -	34,205	150	$108,527	$4·08
to	annu	ally.	- -	- -	- -	- -	3 80
1830			- -	- -	- -	204,773	3 50
1831	15,103	21,406	- -	36,509			
1832	42,210	41,934	- -	83,144	- -	211,017	2 90
1833	28,512	63,920	- -	92,432			
1834	39,855	51,777	- -	91,632	- -	200,277	2 79
1835	19,585	40,387	- -	59,972	- -	143,461	2 39
1836	30,220	78,212	- -	108,432	- -	244,995	2 27
1837	46,574	106,876	- -	153,450			
1838	57,175	71,908	- -	129,083	- -	308,591	2 40
1839	52,930	128,621	- -	181,551			
1840	77,559	85,951	- -	163,510	- -	387,238	2 37
1841	52,273	103,121	- -	155,394			
1842	68,407	73,114	- -	141,521	- -	380,635	2 68
1843	10,917	64,186	- -	75,103	8,557	116,312	2 83
1844	29,832	57,241	- -	87,073	- -	236,963	2 72
1845	58,381		151,021	85,776	11,364	223,919	2 60
1846‡	57,903	95,330	3,620	156,853	- -	378,597	2 41
1847				148,021	- -	370,985	2 50

Tariff Duties on Coals Imported.

The question of how far the coal trade of the United States required protection from an external competition, has, at various times, been the subject of public discussion among the parties interested.

As may be seen in the preceding table, various modifications have been introduced, from time to time, in the scale of duties on imported coals.

The Committee of the Senate of Pennsylvania appointed to investigate the subject of the coal trade, reported March 4, 1834; and, among other important points, stated that they were led to the consideration of the question, "whether the bituminous coal of Pennsylvania can be brought into general use, east of the mountains, for manufacturing purposes, and be transported to the eastern markets upon such terms as to supersede the use of foreign coals?"

The report proceeds to notice the effect that duties on foreign coal had heretofore produced on the sale of American coals, in the markets on the sea board.

In 1815, when the duty on foreign coals was three dollars and sixty cents,

* Parliamentary Tables of Revenue, Commerce, &c.
† Treasury Report U. S., Dec. 3, 1845.
‡ Commercial List of Philadelphia.

the price in New York was twenty-three dollars the chaldron, of thirty-six bushels.

From 1816 to 1823, inclusive, during which time the duty was one dollar and eighty cents, the average price was about eleven dollars.

From 1824 to 1834, the duty was two dollars and sixteen cents, and the average price about fourteen dollars.

For the twenty years prior to 1834, the average price has been about twelve dollars and fifty cents; and, therefore, it has not varied in proportion to the tariff; nor does it appear to have been influenced by the rates of duty—for, in 1821, when the duty was one dollar and eighty cents per ton, the price of coals was fourteen dollars; and, in 1830, when the duty was two dollars and sixteen cents, the price was only eight dollars. The difference in price, it would therefore seem, has been produced by other causes.

From 1824 to 1834, the duty was one dollar and eighty cents a ton, and the average price during the same period, was about ten dollars; yet in the latter year it declined to five dollars and fifty cents, and five dollars per ton.

In 1842, when the duty was one dollar and seventy-five cents, the average price in New York was seven dollars and sixteen cents per ton.

In 1844, with a duty of one dollar, the price was five dollars and fifty-six cents. In 1846, with an ad valorem duty of thirty per cent., or about forty-five cents per ton, the price was seven dollars.

The authors of the Report observe, that there are other causes which co-operate in influencing prices, more than the tariff. The price, heretofore, seems to have been governed, almost entirely, by the scarcity or the demand for fuel.

For ourselves, we think that inferences drawn from the state of the markets at any period reaching further back than the last fifteen or twenty years, are of very little avail, and indeed ought to be discarded, as unsound. Previously to this period, the United States was not a coal producing country. Its fuel was the timber of the forest; it supplied no coal for domestic use in the eastern cities, and consumed but an insignificant amount of the foreign coal; which amount has been decreasing for the last twelve years, even with a diminished tariff. These duties could have exercised no influence on the prices, or upon the supply of anthracite from Pottsville, or of bituminous coals from beyond the Alleghanies; because, in point of fact, neither of them had reached the seaports, previously to the time of which we speak.

There can be no foreign competition now feared in relation to anthracite; and, probably, very little in relation to any substitute for that fuel, in the shape of bituminous coals—foreign or domestic. We do not think that the bituminous coal of Pennsylvania will ever find an extensive sale on the seaboard. The use of anthracite for all domestic purposes is so firmly established, that no other quality will henceforth find admittance into our houses. It is for the home consumption of the interior, and eventually the countries lying north of the great lakes, that the northern coal-fields of the United States may look for increasing markets. For the same cause, there never can be any large demand or sale for foreign bituminous coal at the sea-ports, except, perhaps, near the northern frontier; because its uses are, from the causes we have specified, much more limited on the eastern borders of America than in most parts of the world.

That these are not newly or hastily adopted opinions, may be seen from an article on the same subject, published by the writer in 1840. After reviewing the position of the Pennsylvania anthracite trade from 1820 up to 1839, and that of the foreign importation of bituminous coal along the Atlantic

sea-board, during the same period, the author remarks, "It appears, that in a similar ratio as the consumption of this admirable fuel—the Pennsylvania anthracite—increases, so does the importation of foreign or English coals diminish; and the remark even extends itself to the diminution of Richmond bituminous coal, during a given term of years."

"The anthracite trade of Pennsylvania is decidedly on the increase; while the bituminous coals, borne coastwise or imported, have either remained stationary or have furnished a diminished supply."*

The seven subsequent years of the Boston coal trade has proved that the writer's views were not far from the verified results. The comparative business done in the years 1840 and 1847, are as follows:

	Tons in 1840.	*Tons in* 1847.
Pennsylvania Anthracite received,	73,847	258,093
American Bituminous Coal,	3,299	4,554
Foreign " "	49,997	65,203

Thus while the anthracite importation has increased three and a half times, that of the foreign and the American bituminous coal, has been almost stationary.

Preliminary Sketch of the Coal Fields and Coal Trade of the North American Continent, as at present known to us.

The substitution of mineral coal, or of any other combustible than the timber of its indigenous forests, whether as a domestic fuel, or for the manufacturing purposes of an increasing population, had its origin in America scarcely more remote than the memories of the living generation. In Pennsylvania, the anthracites, which now number by millions of tons, their annual production, were unknown to the community twenty years ago, and had then but commenced to find their way into the dwellings of the wealthier inhabitants of our maritime cities.

It will be remembered, that nearly the whole area of the great basin of the Mississippi, the valley of the Ohio, and the western slope of the Alleghany mountain or Appalachian range, embracing the great central coal-field hereafter to be described, was—although geographically subdivided into several states and terrirories—until after the middle of the eighteenth century, in the partial occupation of Indian tribes. Until about a quarter of a century ago, this immense coal area, taking the country at large, was held to be of small value, even by the civilized successors of the aborigines. The purchases made, at sundry times, by William Penn and his family, and subsequently by the proprietaries, did not embrace any portion of the anthracite districts until 1749, or of the Alleghany bituminous coal region of Pennsylvania, until the year 1768. The acquisition of these coal-fields in no respect influenced the arrangement between the parties; and, to this day, the supply of that description of fuel to the seaboard, is insignificant, when compared with the magnitude of the source from whence it is drawn.

By the terms of the treaty of 1768, which was the last purchase made by the proprietary, they became possessed, with a small exception, of the whole superficial area of the bituminous coal land of Pennsylvania:—that is to say, the entire country between Lycoming creek, the north branch of the Susquehanna, and the head waters of the Alleghany river, down to the Ohio, for *the sum of ten thousand dollars*. The presence of coal, in certain places,

* Report to the Dauphin and Susquehanna Coal Company, by R. C. T., May 1, 1840.

became known about this time; for we have seen maps, of the dates of 1770 and 1777, which, among other places, marked the site of "coal mines" on the Ohio side of the river. In 1785, the first tract which was secured on account of the value of the coal upon it, within the new purchase, was patented near Clearfield; and the first ark load of coal descended the Susquehanna from thence. In 1828, the first cargoes of coal from the Alleghany coal-field at Karthaus, reached Philadelphia and Baltimore; but the distance from market was found too great, and the means of transportation too imperfect, to hold out any hope of a profitable coal business.

The eastern margin of the Alleghany coal-field has been approached in two places from the seaboard by Pennsylvania canals; and, in a third, by the Chesapeake and Ohio Canal in Maryland. It will also be traversed by the Central Railroad. The supply from these sources to the sea-coast is not large; being of course regulated by the limited demand for this species of fuel, of which, anthracite, every where has precedence. It is chiefly in request for gas-works, forges, blacksmiths' use, and for certain industrial purposes. Wherever the two species of coal can be obtained on equal terms, or are equidistant from their centres of production, anthracite maintains its indisputable supremacy. It does not appear probable that Pennsylvania will ever acquire a large market to the eastward for her bituminous coal, so long as her anthracite fields remain unexhausted. For precisely the same reason, it seems to us equally improbable that the anthracite coal trade with the eastern cities will be perilled by the existence of bituminous coal-fields in New Brunswick, Nova Scotia, and Cape Breton. Where there is any thing like an equal choice, the demand for Pennsylvania and Virginia bituminous coals will continue small at the eastern ports, owing partly to the causes named, and partly to the heavy cost attending its transportation. Only one hundred and seventy-five tons of Pennsylvania bituminous coal are reported to have reached Boston, during the year 1846, while the supply of the same description of coal from Virginia and foreign countries also simultaneously decreased. But there is another, a better, and a vastly more extensive market, to which Pennsylvania, Ohio, and probably Michigan, may ultimately look for the disposal of their bituminous coal. We refer now to the whole of the countries bordering upon the North American Lakes; embracing a large portion of the Canada frontier, now rapidly filling up with settlements, and all the opposite portions of the United States. These, in good time, it seems to be very certain, will more than compensate for the loss of a monopoly of two or three ports nearest to the coal-fields of Nova Scotia. Besides the demand for domestic and manufacturing uses, it is probable that much coal will be needed for smelting the copper ores of Lakes Huron and Superior.

From the Cumberland and Frostburg angle of the Alleghany coal-field, there seems a better prospect for the bituminous coal trade, than from Pennsylvania, although, probably, the larger part of the amount produced will be consumed in iron works on the spot. The conveniences for transporting the Cumberland coal to Washington and Baltimore, and for a certain export trade, added to the very high intrinsic value of the coal itself, and the comparative remoteness of the anthracite districts, will secure to this region a fair share of the bituminous coal business.

Surveys of vast bodies of land were made in western Virginia and Kentucky, in 1795, and even previously to the revolution; but we perceive no evidence that those lands possessed any other than surface value, or that the presence of seams of coal, if known, conferred any additional value upon

them. Even at the present moment, we know that enormous areas yet remain untouched, and that the time is not yet arrived when they can be estimated beyond their mere agricultural prices. It is only along the flanks of the principal streams, such as the Ohio and the Kanawha, that the vegetable fuel has, in some measure, given place to the mineral combustible.

At the period of running the boundary line between North Carolina and Virginia, in the year 1728, the narrator describes the country as yet in its pristine state of savageness. Settlements extended no further west from the Atlantic than a hundred miles, and the remainder was still the home of the Indian and the feeding ground of the Buffalo.* It was towards the close of that service, although the western extremity of the line was still left unfinished, that the expedition found itself amongst unknown mountain ranges, and were still remote from the eastern flank of the great Alleghany coal-field, and from that wild, bordering, elevated country of Tennessee, of which we yet know but little beyond the late reports of Dr. Troost.

South-west from hence, through the state of Tennessee, and far into the then French province of Louisiana, the coal-field has received but partial investigation. That part which terminates in Alabama was, but a few years ago, a part of the Cherokee country, from which the aborigines were then removed.

Along its course through Kentucky, Tennessee, and Alabama, many iron works have been established within a few years; but the insular position of this part of the region is unfavourable to the transportation of coal to distant markets.

The last mentioned state constituted the easternmost part of the original territory of Louisiana, and the mountainous portion of it yet retains its wilderness character. Even so late as 1800,—what in 1817 constituted the separate territory of Alabama,—its entire population did not exceed 2000 persons.

We have traced, in few words, the great Alleghany coal-field in its progress through eight of the Atlantic states. With the exception of a small area towards the north, it lies so remote from the seaboard, that it is not probable that much coal will find its way in that direction. On the south, its best market is the cities on the Gulf of Mexico; and, already, great progress has been made in railroads and inland navigation with that view. These cities now pay enormous prices for coal that has descended the Ohio, the Mississippi, the Tennessee, and the Cumberland rivers, by very long and circuitous channels.

There are no reliable returns of the quantity of coal which descends to these markets, nor of the ordinary production of the states. Western Virginia, in 1840, returned about 300,000 tons as her annual production. In the Ohio division of the Alleghany coal-field, coal was known previously to 1777, since it is marked on Captain Hutchin's map of that date, although not mined until many years after. In 1840, it returned 125,000 tons, as her share of the annual production; a small yield, certainly, for a highly favoured district of 11,900 square miles.

But Ohio has since found a northern market for her coal, through the port of Cleveland, as Pennsylvania has done through her port of Erie; and hence, through the lakes to the Canadas, and the countries which border the great lakes. The present export of coal from thence, is about equal to one-half of the entire production of Ohio seven years ago; and nearly equals

* History of the Dividing line betwixt Virginia and North Carolina, by Colonel Wm. Byrd, Esq., of Westover, 1728.

the whole consumption of the state in 1838. Erie also received 70,000 tons of bituminons coal, in 1847.

The Maryland division is one of the smallest of the Alleghany districts; yet as its coal is probably the best in America, there is no doubt but it will contribute a large quota of coal, and much iron, to the Atlantic ports, by means of the railroads and canal, now in full operation.

We close our circuit of the Alleghany coal-field by returning to western Pennsylvania. Although in 1840, this section returned 415,000 tons, the quantity was evidently much under-rated; and we cannot assume the amount now annually raised at less than one million of tons. One-fourth of this quantity descends the Ohio river; one-half is consumed at Pittsburg and in the establishments around that great manufacturing city; the remaining fourth is consumed in the interior.

Let it be borne in mind, that all this business has sprung up within the memory of persons now living. In the year 1753, there was, probably, no white man living within the limits of the present city of Pittsburg; and, in 1775, only a few cabins were standing there. Yet, in our day, three-fourths of a million of tons of coal are annually received there, and the extent of the iron manufacture is so great as to confer upon the place the title of "the Birmingham of America."

Not more than 40,000 tons of bituminous coal annually pass through the state canals, eastward. This is the maximum of the present demand for this description of coal. The largest portion of this is deposited at the iron works along the route. A very small quantity passes through the Union Canal. The remainder is either shipped at Havre de Grace, or is conveyed in boats to the Delaware.

Another outlet, besides that of Erie, for the northern section of the Pennsylvania coal-field, has been in existence several years. By the Tioga Railroad the coal from the little isolated coal-basin of Blossburg passes into the state of New York, and thence as far as Lake Ontario on the north and Albany on the east. The detached coal-basin near Towanda will, when the meditated improvements are completed, furnish another portion of the state of New York with mineral coal. From the port of Erie, above mentioned, more than 20,000 tons of Pennsylvania coal are annually shipped for exportation to Canada, &c.

Such is the great Alleghany coal-field, whose outline and resources in mineral fuel, we have thus traced. It is impossible to contemplate its gigantic proportions, and its enormous, yet almost untouched resources, without being struck with the magnificent field which it presents for future enterprise.

There is a small detached basin of semi-bituminous coal, lying in Pennsylvania, to the east of the Alleghany Mountain. This locality is called the Round-top Mountain. The coal at present is only employed for the consumption of the neighbourhood, on account of the want of means for transportation.

We pass now to the great depository of anthracite in Pennsylvania; the only one, in fact, of material value on this continent. Here we have the most interesting assemblage of isolated coal-basins that the world has yet produced, or the geologist investigated. We can only now advert to them with extreme brevity; but here we can afford to be brief.

The physical features of this anthracite country are wild; its aspect for-

bidding; its surface broken, sterile, and apparently irreclaimable. Its area exhibits an extraordinary series of long parallel ridges and deep intervening troughs. This group of elongated hills and valleys consists of a corresponding number of axes, all or nearly all of which range in exact conformity to the base of the Alleghany Mountain. When viewed from the latter, they bear a striking resemblance to those long rolling lines of surf, wave behind wave, in long succession, which break upon a flat shore. A century ago a large portion of this region had received, upon the maps, the not-unapt title of "The Wilderness of Saint Anthony."

Three-fourths of a century after, when the greater part of this area was still in stony solitude—when this petrified ocean, whose waves were sixty-five miles long, and more than a thousand feet high, remained almost unexplored,—a few tons of an unknown combustible were brought from thence to Philadelphia, where its qualities were to be tested, and its value ascertained.

But the miner has entered into this Wilderness of Saint Anthony,—and canals have penetrated it,—and railroads have traversed it;—basin after basin of this combustible have been discovered in it;—tract after tract have supplied productive collieries in it;—until, in a single year, [1847] it had furnished the surprising amount of three millions of tons; [or an aggregate of near nineteen millions of tons of anthracite within the last quarter of a century;] and 11,439 vessels cleared from the single port of Philadelphia, in that season, loaded with a million and a quarter of tons, for the service of the neighbouring states.

Such then is the anthracite region, and such its rapid progress in production. To Pennsylvania, in relation to the future, its value, in connection with the corresponding advance of her manufacturing industry, surpasses the power of computation.

Some detached spots in the states of Rhode Island and Massachusetts, have, from time to time, furnished a small and irregular supply of anthracite. The presence of this coal, indeed, was known many years before the Pennsylvania anthracite was first mined. Numerous efforts have been made, from time to time, to explore the coal beds in these places, but they have generally ended in failure; owing, as we conceive, to the disturbed and contorted structure and metamorphic character of the inclosing rocks.

In attempting to introduce a fuel so difficult of ignition, at a period when the only coal known and used was of the fat bituminous variety, imported from Europe, and when no adaptation for burning it had been matured, it is not remarkable that the semi-crystalline anthracite of Rhode Island should acquire a bad reputation. Notwithstanding this, and its proverbial unfitness for all purposes of combustion, we believe in its intrinsic excellence—in which belief, both practice and the result of its analysis fully bear us out—and that there exists no better anthracite in the new world. But, as we before suggested, the unusually modified nature of the inclosing rocks, the tortuous and schistose characters which they now assumed, and in which the most experienced geologist might fail to detect the representatives of the coal measures, seem to present insuperable difficulties in working the combustible to advantage.

Before quitting the Atlantic slope, we have to notice a bituminous coal-field, small in area, yet rich in the abundance of its coal, and most favorably situated in regard to facility of transportation. Almost in the centre of Eastern Virginia, between N. latitude 37° and 38°, lies the little basin of Richmond, or Chesterfield. This field contains the oldest worked collieries

in America. Mr. McClure described it more than thirty years ago; and it was, apparently, for many years, the only point in the United States where bituminous coal could be procured, and shipped coastwise. The amount of this export trade does not appear to have ever been large. The official returns show an increase from 48,000 tons in 1822, to 142,000 in 1833, and then annually diminishing to 65,000 tons in 1842. In the southern part of this field, however, new collieries have been opened, which sent down about 50,000 tons of coal in 1847.

Crossing from hence to the north-west, we have next to mention a coal-field of no mean size, yet at present known but to few, even within its immediate limits. It occupies an area of from three to five thousand square miles, in the centre of the peninsula of Michigan; communicating readily with all the great lakes. The amount of coal mined here, is very trifling at present, the beds being quite thin; and this country is so recently occupied, that as yet there has been no demand for this description of fuel. But it seems destined, ultimately, to be of importance, as the use of coal becomes general, and as the timber of the forest decreases. It possesses remarkable geographical advantages; being the only coal-field in a vast extent of country. As population flows into the countries bordering on the lakes, this Michigan coal-field, although not so productive as some others, cannot but become, ultimately, of considerable value.

Passing now to the southward, we enter the great Illinois coal-field, which occupies an extent nearly equal to that of England; yet the State has but recently commenced to make use of the coal with which nature has so bountifully provided her. Except in the vicinity of the larger towns and rivers, the business of mining coal here has made but small progress.

The existence of this combustible was proved by the French explorers at an early period. It was certainly known to Father Hennepin in 1679, almost a hundred years before the Pennsylvania coal was discovered, and is marked on the map which illustrates his journal. He points out a "cole mine," above Fort Crevecoeur, on the Illinois river, near to the site of the present Ottawa. He further states, that in this country, then occupied by the Pimitoui or Pimitewi Indians, now Peoria, "there are mines of coal, slate, and iron; and several pieces of fine red copper, which I have found, now and then, upon the surface of the earth, make me believe that there are mines of it."* This is the earliest notice, on record, of the existence of coal in America; and the same may be said of the bouldered masses of native copper, which we know to have been drifted from their original sites, only discovered but recently, on the borders of Lake Superior. At this period, viz. from 1680 to 1698, and subsequently, the Illinois river formed part of the main route from the French missions on the Niagara, by Lake Karegnonde, now Huron; by Lake Illinouach, or the Lake of the Illinois, now Lake Michigan, to the Mississippi, and thence down to its very mouth.†

We confess to entertaining strong feelings of interest in the description of these newly explored countries, by the good missionary fathers of those days; among whom stand conspicuous the names of Hennepin, Gabriel, Zenobe, Marquette, and, a few years later, of Father Charlevoix, and

* Map and description of a large country newly discovered in the Northern America, situated between New Mexico and the Frozen Sea; together with the course of the great river Meschasipi. By Father Lewis Hennepin, Missionary Recollect and Apostolic Notary. 1698.

† The same line, from Lake Michigan to the mouth of the Illinois river, also formed the north-west boundary line of the country which was ceded by the French to Great Britain, in 1763.

others. They were men of observation, yet of simple lives—messengers of peace and good will—mediators between the native savage and the white invader. Here, in these remote missions, they erected the first Christian altars, and planted the first germs of civilization; they shared the perils of exploring unknown regions, and they were the intelligent chroniclers of the times;—the faithful and simple narrators of those hazardous voyages.

The records that these religious men have bequeathed to us, form the most interesting, the most valuable statistical memorials that we possess of the aboriginal state of the interior of this Continent. It were a service not unworthy of some man of leisure, to collect together, ere they are totally lost, these and many other illustrations which distinguish the progress of French discovery, and which so especially belong to the history of this Continent.

On occasion of the peace of 1763, Colonel Croghan was sent by the British government to explore the country adjacent to the Ohio river, and to conciliate the Indian nations. This officer was captured by a party of Indian warriors, and carried up the Wabash river, through the Illinois country. At a point on this river, apparently near where Williamsport or Covington now stands, the author states that "on the south side of the Ouabache runs a high bank, in which are several fine coal mines." This is the earliest notice of coal in this part of the coal-field.*

Respecting the coal region of Missouri, we have very incomplete information. The geological distribution of the formations there are ill defined. It will, no doubt, be found, on attentive examination, that the coal measures exist in numerous patches or detached areas, whose boundaries are influenced by the physical configuration of the country, and that the coal series, although scattered at intervals over a great surface, do not cover, at any point, any very large areas; for as the carboniferous strata approach so nearly to the horizontal position, and, moreover, not being of much thickness, a large proportion of productive coal land has been removed by the erosion of the rivers, and similar causes of denudation and excavation. This is also apparently the case in relation to the Illinois coal field, last mentioned. The patches of coal formation are scattered all across the State of Missouri, and appear at intervals over a wide tract of country; stretching through a part of Arkansas into the territory now occupied by Indian tribes, and thence, for an unknown distance, towards the south-west, apparently into Texas. The earliest notice of the existence of thick seams of excellent coal in the Osage country, bordering the river of that name, we believe, was furnished by Captain Pike, when on his exploring expedition, in 1806.

Of Texas, there exists at present no geological map or description. Both coal and anthracite are described as existing at the head waters of the Trinity, the Sabine, and some other rivers; but this country is, as yet, in too unsettled a state, to encourage mineral explorations, to any extent. It appears that coal, in detached areas, as in Missouri, crosses Texas and enters Mexico. An important coal-field which crosses the Rio Grande, in N. latitude 27° 30′, near Loredo, has very lately been examined by an officer attached to the United States army of invasion. This coal formation bears away into the interior of Mexico, in a south-west direction, by Guerrera, on the Salado river, where it is of good quality. Coal is also found in the provinces of Oajuca and Vera Cruz, and in abundance at Tehuantepec; doubtless geologically newer than the true coal.

* Printed from the original journal, in the Monthly American Journal of Geology. 1831. Vol. I. p. 257.

We can scarcely speculate here on the existence of bodies of true coal, along the Pacific slope of this Continent. In some cases brown coal has been mistaken for the older coal. In the midst of the Rocky Mountain range, Captain Fremont discovered coal beds of dubious geological age; intermediate, apparently, between the brown coal and the true coal. A coal bed of considerable thickness has lately been noticed in the Raton mountains, east of Taos, and on the head waters of the Canadian river.

The scope of the present sketch leads us now to notice one of the most interesting geological phenomena in the new world. We refer to that enormous range of brown coal, apparently of the tertiary period, which follows the eastern flank of the Rocky Mountains, from near Mexico even to the Polar sea. Nature has, indeed, worked on a truly gigantic scale. We see here a deposit of brown coal, so extensive that the magnitude of its proportions is far from being defined; yet enough is known to show that it exceeds, in longitudinal range and breadth, all others on the present surface of our planet. So far seems to be established, that, allowing liberally for interruptions in continuity, supposing that any such exist, it occupies thirty-five degrees of latitude, or near 2500 miles, following its oblique range; and has a maximum breadth, at N. latitude 48°, of four hundred miles; the whole area, as near as we can venture to compute, being 250,000 square miles, or one hundred and sixty millions of acres—more than twice the size of Great Britain. Compared with this, the largest coal-fields in the world are absolutely small.

Should it prove that the coal, which has been traced at no very distant intervals, westerly from Mackenzie's river to the Icy Cape, by Point Barrow, and into Behring's Strait,—along the north coast of Russian America,—is also of the same geological age as that which ranges parallel with the Rocky Mountains, we might add twenty degrees more to the thirty previously mentioned; while, at the same time, the oblique direction of the latter adds five degrees more to the total range.

Turning to the southward, after an uncertain interval of twenty-five degrees, we find ourselves again on coal strata, apparently of similar age to the northern zone just described, and occupying about two thousand five hundred miles more. At certain points along the Pacific side of the southern Mexican provinces, from the Isthmus of Tehuantepec to that of Panama; and then, with a few interruptions, continuing all down the western side of South America to the Equinoctial line; and thence to Lima; and again appearing on the coast and adjacent islands uninterruptedly from Valparaiso to below Chiloe Island, and even through Patagonia, at least as far south as 50° lat., a belt of brown coal formation and tertiary strata, borders the Pacific, or skirts the Andes. At all of the points which have been successively named, investigations into the quality of this coal and its fitness for the purpose of steam navigation, have, for some years past, been made, and the details will be furnished in the appropriate place.

Commencing our admeasurement near the Isthmus of Panama, in N. lat. 10°, and descending to S. lat. 50°, the traces of a tertiary formation, containing lignites, and fossil wood, are reported to extend, almost continuously, for four thousand miles. We are within reasonable bounds when we assume two thousand five hundred miles, as the extent, with occasional interruptions, in which brown coal or carbonized wood is traceable.

Thus there exists, ranging nearly with each other, but separated by a great breadth of unexplored ground, two apparently contemporaneous belts, 2500 miles long each, extending through both continents to points at least

one hundred and twenty degrees asunder,—namely, the Frozen Sea or perhaps the Icy Cape to the north, and southern Patagonia to the south. We think we cannot be far in error if we assign five thousand miles, out of eight thousand four hundred miles, to this remarkable coal formation. We do not know if this statement be entirely new. Were it not supported extensively by good geological authority, and by a series of facts and observations which will scarcely be called in question, we should hesitate extremely ere we gave it circulation.

Returning once more towards the north, coal is mentioned as occurring near Monterey, in California. Petroleum and asphaltum, and perhaps anthracite, occur in this parallel. Captain Fremont discovered coal, probably brown coal, in the centre of the Rocky Mountain chain, at an elevation of 6820 feet above the sea. Another coal-field was found by Captain Fremont, in his recent expedition, in N. lat. 41½°, extending from 110° to 111° W. long. Both of these deposits appear to be about the Oolitic age. There is a coal range at an elevation of more than 7000 feet, in the great mountain range, east of Santé Fé, in about N. lat. 37°; but of what geologic age we know not.

In Oregon we have had notices both of coal and lignite, from various explorers. Good coal is reported in Vancouver's Island, in Queen Charlotte's Island, Millbank Sound, and other points on the western border of British America. Passing round by the undetermined coal-beds of Russian America, there appear to be various scattered points within the Arctic circle, where coal has been discovered by our enterprising navigators. At Prince Regent's Inlet, at Byam Martin's Island, and Mellville Island, both true coal and brown coal were obtained.

Within the arctic regions other considerable bodies of the newer coal are known to exist, particularly at Disco Island, Hasen Island, and on both sides of Greenland.

All these northern coal localities seem scarcely more than mere objects of geological interest; for, in regard to their practical value, all that is known to us at present is their mere existence. Still, it can never, surely, be held as a matter of no importance, the fact of this local distribution of mineral combustible, throughout regions which have no timber, or even shrubs, to serve the purpose of fuel.

Canada and the territory west of it, for a vast space, contains no known deposit of coal. This country is destined to be tributary to the states of Ohio, Michigan, and Pennsylvania, for her future supply of mineral fuel, which can be transported at a very cheap rate through the chain of inland lakes.

New Brunswick, Nova Scotia, Cape Breton, and Newfoundland, make up, by the prodigious expansion of the coal formation in that quarter, for the deficiencies of the upper province.

At what period mineral coal first attracted attention, and was applied to the service of the original colonists, does not appear. The business of the General Mining Association, sole lessees of the enormous coal-fields of Nova Scotia and Cape Breton, did not commence until 1827, but the coal of Cape Breton has been worked for sixty years at least. In the southwestern part of the province of New Brunswick, the mining of coal seems to have commenced a little earlier, but the returns exhibit a meagre amount of business.

In Newfoundland coal is mentioned at an early period; and, in a climate not particularly adapted to the growth of timber for fuel, the substitute was gladly welcomed.

The coal trade of Nova Scotia and Cape Breton, is of comparatively modern date. It furnishes supplies to the cities on the St. Lawrence, and a few thousand tons annually find their way, with or without commercial interposition, to the ports of Boston and New York, where, however, the use of anthracite is so completely established, especially for domestic use, as to exclude, in great measure, the smoky bituminous coals, come from where they may.

The coal-fields of British America, although possessing iron ore in great abundance, have no iron works established within their limits. It is no wonder, indeed, when we see regions so highly favoured by natural resources and advantages, neglected, or sacrificed to the paralizing influences of an imbecile monopoly.

In the foregoing outline we have traced, with such brevity as the subject permitted, the prominent features of those vast depositories of mineral coal which nature has so bountifully distributed over the American continent. We have shown, that the mining of this coal; the establishment of an important coal trade; the employment of the fuel in industrial arts, in steam engines and steam vessels, on railroads and canals, in blast furnaces, and iron works, and factories; in fact, its application in a thousand forms, is but of yesterday's growth. We have shown, too, that a portion—immeasurably the larger portion—of these prodigious areas of coal formation, has still no appreciable value, but continues at present wholly unappropriated. It will, doubtless, long remain in reserve, for the service of other generations.

Still, if we measure the future by the past—and we feel assured that we may safely do so in a vastly accelerated ratio, taking Pennsylvania as an example and admitting the surprising increase of population as an essential element in the calculation—the production and conversion of iron and coal, with all their attendant and ever increasing uses, together with the influence they cannot fail to exert upon agriculture, involve results of which we have now but a remote perception. We cannot but think that the close of the present century will witness an advance in the industrial resources of the country, and a consequent extension of domestic prosperity such as it may be presumptuous, at the present moment, on our part, to anticipate.

THE FOLLOWING STATEMENT

Was prepared with a view to show the progress and prominent authors of the State Geological Surveys, the names of *the principal contributors to geological discovery in the United States*, and, also, of those of British America and other portions of the American continent, chronologically arranged. It will be a matter of regret if we have omitted any names that are entitled to appear upon our list of principal workers in the geological field; but we fear that it is unavoidable.

UNITED STATES.	William McClure, Geology of the U. S. (1809,) 1817, 1822; Prof. Cleaveland, 1816.
MAINE.	Chas. T. Jackson, M.D., Survey of the State, appointed in 1836, 3 Reports, 1837, 8, 9; Prof. Cleaveland.
NEW HAMPSHIRE.	Dr. Jackson, nominated 1840, reported 1841.
VERMONT.	Prof. C. B. Adams, State G. Survey, appointed 1845, with Prof. Hitchcock; Prof. Emmons, 1844.
MASSACHUSETTS.	State Survey: Prof. Hitchcock, appointed 1830, published report 1833, 700 pages; re-surveyed by the same in 1837; final report in 1840; Dr. C. T. Jackson, in 1838, 1840; W. C. Redfield, 1841; Prof. Hitchcock, 1845; C. Lyell, 1845.
RHODE ISLAND.	L. Vanuxem, 1825; Dr. Meade, 1820; State G. Survey: Dr. C. T. Jackson, appointed 1839, reported 1840; C. Lyell, 1845; Prof. Emmons, 1844.
CONNECTICUT.	State G. Survey: Prof. C. U. Shepard, report 1837; also, Prof. J. G. Percival, report 1842; Prof. Hitchcock, 1841; W. C. Redfield, 1841; W. W. Mather, 1834; Dr. Barratt, 1845; J. D. Whelpley, 1845.
NEW YORK.	State G. Survey: Profs. Emmons, Mather, L. Vanuxem, L. C. Beck, T. A. Conrad, and J. Hall, appointed in 1836, 5 annual reports, final report in — vols. with geological map; Van Rensselaer, 1825; Amos Eaton, 1820, 1824, 1830; W. C. Redfield, 1841; Prof. Dewey, 1845; R. C. Taylor, 1847.
PENNSYLVANIA.	Cist, 1821; P. A. Browne, 1825, 1831–2; Dr. G. Troost, 1826; G. W. Carpenter, 1828; Silliman's Journal, 1830; G. W. Featherstonhaugh, 1831; R. C. Taylor, 1832, 1843; Packer's Report, 1833–4; Prof. Silliman; W. E. Logan, 1842; State G. Survey: Prof. H. D. Rogers, commenced 1836, 6 annual reports, 1836 to 1842; W. R. Johnson, 1839, 1841; Dr. R. Harlan; Mining Journal, Pottsville; M. Chevalier, 1839.

NEW JERSEY.	L. Vanuxem, 1822–8; Dr. S. G. Morton, 1828–9, 1834; State G. Survey: H. D. Rogers, ordered in 1835, first report 1836, final report 1840; C. Lyell, 1842–5; W. C. Redfield, 1841–3; W. Lonsdale, 1845.
DELAWARE.	Dr. S. G. Morton, 1828, 1834; State G. Survey, 1837: Prof. J. C. Booth, two annual reports, one final report.
MARYLAND.	H. Hayden, 1820; State G. Survey: Dr. J. T. Ducatel, commenced 1834, seven annual reports; P. T. Tyson, 1837; T. A. Conrad, 1830–6, 1841; Prof. Silliman, 1838; L. Vanuxem, 1841.
VIRGINIA.	State Survey: Prof. W. B. Rogers, appointed 1835, six annual reports; Dr. S. P. Hildreth, 1835; R. C. Taylor, 1834; T. G. Clemson, 1835; Prof. Silliman; Prof. Bailey; C. Briggs; H. C. Lea, 1843.
NORTH CAROLINA.	State G. Survey: Prof. Olmstead, 1824–5; W. C. Redfield, 1841; Prof. E. Mitchell; J. T. Hodge, 1841–3; C. Lyell, 1842; T. A. Conrad, 1843; R. C. Taylor, 1845.
SOUTH CAROLINA.	L. Vanuxem, 1826; C. Lyell; M. Tuomey, Dr. R. W. Gibbes, 1845.
GEORGIA.	J. R. Cotting, State Survey, commissioned 1836, report 1841; J. H. Couper; C. Lyell, 1842.
WEST FLORIDA.	J. L. Williams, 1827.
EAST FLORIDA.	T. A. Conrad.
ALABAMA.	I. Lea, 1833; Prof. Brumby, 1838; T. A. Conrad; Dr. R. Harlan, 1841; C. Lyell, 1845–6; Dr. J. H. Kain, 1845.
MISSISSIPPI.	B. L. C. Wailes, 1845; Dr. M. W. Dickerson, 1845.
LOUISIANA.	Brackenridge, 1814; Darby, 1818.
ARKANSAS.	T. Nuttall, 1819, 1821; H. R. Schoolcraft, 1818; Major Long, 1820; G. W. Featherstonhaugh, 1834; A Geological Survey recommended by the Governor, Nov. 1846.
TENNESSEE.	State G. Survey: Dr. G. Troost, 1831 to 1846, 8 reports; T. A. Conrad, 1835; Dr. D. D. Owen.
KENTUCKY.	D. Trimble, 1836; State G. reconnoissance: Prof. W. W. Mather, 1838; W. Cooper, 1832; C. Lyell, 1842.
OHIO.	Dr. S. P. Hildreth, 1835; State G. Survey: Prof. W. W. Mather, assisted by Dr. S. P. Hildreth, Prof. J. Locke, Prof. J. C. Briggs, J. W. Foster, 2 reports, 1837, 1838; Prof. Briggs, 1838; Prof. J. Hall, 1843; Dr. J. S. Taylor, 1845.
MICHIGAN.	Schoolcraft, 1821; State G. Survey: Dr. D. Houghton, 1838, 4 reports to 1845; Dr. C. T. Jackson, 1845; numerous Reporters of Surveys in the Copper Region of the north.

INDIANA.	State G. Survey: Dr. D. D. Owen, 1837, 2 reports, 1837–8; Prof. J. Locke; Prof. J. Hall, 1843.
ILLINOIS.	Father Hennepin, 1680; Colonel Croghan, 1763; Dr. D. D. Owen, 1839, 1844; Prof. C. U. Shepard, 1838; Prof. J. Locke; Prof. J. Hall, 1843.
MISSOURI STATE.	Captain Pike, 1805–6–7; Bradbury, 1809–10–11; Brackenridge, 1814; Major Long, 1819–20; H. R. Schoolcraft, 1818; Dr. Daubeny, 1838; T. G. Clemson, 1838; J. N. Nicollet, 1841; J. T. Hodge, 1842; G. W. Featherstonhaugh, 1835–6; Prof. C. U. Shepard; T. Nuttall, 1819; Major Cass, 1820.
MISSOURI TERRITORY.	Lewis & Clarke, 1804–5; Capt. Pike, 1805; Major Long, 1819–20; Dr. James, 1819–20; H. D. Rogers, 1834; J. N. Nicollet, 1838 to 1841, reported in 1843, with his large map; G. W. Featherstonhaugh, 1834–5; Brackenridge, 1814; E. Harris, 1845; Lieut. A. R. Johnston, 1845.
WISCONSIN.	Dr. D. D. Owen, 1839, 1844; Prof. J. Locke, 1840, 1842; Major Long, 1820.
IOWA.	J. T. Hodge, 1842.
OREGON & UPPER CALIFORNIA.	Capt. Fremont, 1843–44; Wilkes's Exploring Expedition, 1841; Prof. J. Hall, 1845; Prof. J. W. Bailey, 1845.
TEXAS.	W. Kennedy, 1844; Lieut. B. P. Tilden, 1847.
NEW MEXICO.	Don Manuel Alvarez, 1847; Lieut. Col. Emory, 1847.
MEXICO.	A. Von Humboldt, 1809, 1823; M. Chevalier, 1835; Lieut. B. P. Tilden, 1846–7.

BRITISH AMERICA.

NEW BRUNSWICK.	Dr. A. Gesner, 1843–5; Henwood, 1840; Capt. Bayfield; W. E. Logan, 1845; J. W. Dawson, 1845.
NOVA SCOTIA.	Messrs. Jackson and Alger, 1841; Halliburton; Dr. A. Gesner, 1840–2–3–5; J. W. Dawson, 1843–5; R. Brown, 1843; W. E. Logan, 1842–5; C. Lyell, 1843.
CAPE BRETON.	The Abbe Raynal; R. Brown, 1845; J. W. Dawson, 1845; C. Lyell, 1842.
NEWFOUNDLAND.	Mr. Jukes; Sir R. H. Bonnecastle.
CANADAS.	Dr. Bigsby, 1819–20; Provincial G. Survey: W. E. Logan, 1842–4–5; A. Murray, 1844–5; Capt. Bayfield.
NORTH-WEST TERRITORY.	Capt. Franklin, 1820–1–5–6–7; Dr. Richardson, 1820–1–5–6–7; Sir A. Mackenzie, 1789, 1792; Mr. Hearne, 1769; Dr. Bigsby, 1821, 1824; Capt. Parry, 1819–20–4; Capt. Ross, 1830–1–2–3; Mr. Isbister, 1845; Capt. Beechy, 1825–6; Capt. Back, 1833; Lieut. Wilkes; Capt. Fremont, 1843–4; Messrs. Simpson and Dease, 1837–8; Edw. Harris, 1845.
GREENLAND.	Capt. Scoresby; Capt. Clavering.

THE ALLEGHANY OR APPALACHIAN COAL-FIELD,

COMPRISING WHAT IS FREQUENTLY DENOMINATED THE GREAT CENTRAL BITUMINOUS COAL RANGE OF THE UNITED STATES.

We may add, also, that in some of our most ancient topographical maps, this vast range was formerly known as the "ENDLESS MOUNTAINS."

Some of our cotemporaries, following up the suggestion of Mr. Darby,* prefer the term Appalachian, to that of the Alleghany, coal range, and, apparently, with some reason. That able geographer was no doubt governed by good evidence, in favour of its adoption in its generic and most extended sense, while admitting the word Alleghany in what may be termed its specific or local application: thus employing the one to designate an entire system; the other as an integral part of that system. We think that it was so meant by Col. Long in 1831,† and by one or two cotemporary geologists. More than a century before this, we remark the use of the generic term, "the vast Appalachian range of mountains," by Col. Byrd, in his lively narrative of the running of the dividing line between North Carolina and Virginia, in 1728; which diary did not appear in print until 1841.‡

Our cotemporaries of the Virginia and Pennsylvania geological surveys, we believe, have adopted the general scope of this designation, yet with some modification; conferring, if we mistake not, the term Appalachian on the magnificent central and elevated region, within whose borders yet slumber, in undisturbed darkness, untold millions of acres of coal and iron.

It seems to us, however, that the entire Appalachian system of the geographers was intended to comprise a widely extended series of mountains, some of which are far removed, by space as well as by geological structure, from that which is generally designated, throughout its course, the Alleghany coal-field. The Alleghany is therefore a coal range, *par excellence*, which the Appalachian certainly is not. Hence appears the peculiar fitness of the term "Alleghany coal-field."§

Col. Byrd's reference to the Appalachian mountains seems to indicate merely the Blue Mountain and those parallel ranges which stretch co-extensively with the main escarpment of the great coal-field.

We would, therefore, in the following pages, venture the use of this phrase, wherever, in its local application, it is unmistakable: for our conviction is, that whether we choose to adopt it or not, it will ever continue a term in general acceptation—a name imperishable as that of the Alps.

Let us add here, that we find it marked upon our maps, of every age, and

* Darby's Geology of the United States.

† Monthly American Journal of Geology. 1832. P. 347.

‡ Westover papers. Petersburg, Va. 1841.

§ As to the orthography of Alleghany or Allegheny, we know of no standard; any more, in fact, than there is for all the other Indian names. It appears to be commonly written in the first manner, and here we follow Darby.

in all parts of its course, from the southern borders of New York state, even into Tennessee. We even see the name, "Alleghany Mountains," prolonged eight hundred miles further northward, as far as Cape Gaspè, and the gulf of St. Lawrence.*

According to the scheme of Darby, the entire Appalachian system occupies one hundred and twenty thousand square miles; Messrs. Rogers estimate it at 130,000. Of this great area, the bituminous coal field of the Alleghanies occupies about one half.

In the primitive maps, which have come under our notice, no part of this range is recognized as essentially Appalachian, beyond the northern limit of Alabama; the country, first of the Appalachians and since of the Cherokees. Daniel Coxe, an admissible authority in geographical nomenclature, shows us, in his description of the "province of Carolana," A. D. 1722, that this prolonged range of mountains in Alabama, formed a part of the royal grant of 1630, half a century before its supposed discovery by the French, and was named the "Palachean Mountains."† It has generally been admitted, that the warlike Indian tribe of that name, for the most part occupied the rich low ground which bordered on the gulf of Mexico. They were there first found by the Spaniards in 1528; and there, in the "Appalachee country," subdued only as late as 1702, they have left their traces in corresponding local names. The Appalachicola and the Appalachie rivers, yet mark their origin, as does the bay of Appalachie, where Narvaez first landed in 1528. The map of M. G. De L'Isle, in 1720, shows the site of the town of the Appalaches, in 1540, a little south of the present city of Mobile.‡

In Father Charlevoix's map, also, in A. D. 1720, republished in English in 1766,§ the Appalachian mountains appear, extending to about N. lat. 35°, which again is the northern limit of Alabama, as previously adverted to, and nearly corresponding with the north boundary of what was then South Carolina, ceded by France to Great Britain, in 1763. The same mountains were assigned by Father Hennepin and Mons. La Salle as the boundary of Louisiana, and were so considered by the Spaniards, and previously by the French.‖

Mr. Jefferson, who wrote his "Notes on Virginia," in 1781, ascribes the origin of the term to the Indian tribe of Appalachies, who resided on Appalachicola river. "Hence," he observes, "the mountains giving rise to that river, and seen from its various parts, were called the Appalachian mountains; being, in fact, the end or termination only, of one of the great ridges passing through the continent. European geographers, however, extended the same, northward, as far as the mountains extended; some giving it, after their separation into different ridges, to the Blue Ridge, others to the North Mountain, others to the Alleghany, others to the Laurel Ridge; as may be seen in their different maps. But the fact, I believe, is, that none of these ridges were ever known by that name to the inhabitants, either native or emigrant, but as they saw them so called in European maps."¶

* Martin's Statistics of the Colonies of the British Empire. Pp. 147—151.

† Description of the Province of Carolana, by the Spaniards called Florida, and by the French La Louisiane. By Daniel Coxe, of New Jersey, 1722.

‡ Carte de La Louisiane, par Guillaume De L'Isle, de l'Academie Royale des Sciences. Amsterdam, MDCCXX.

§ "A map of the British Dominions in North America, as settled by the Treaty of Peace, 1763."

‖ Brackenridge's Louisiana. 1814, p. 26.

¶ Jefferson's Notes on Virginia, p. 26. 1784.

In the authorities we have cited, we think we have perceived evidence of the actual extent and limit of the Appalachian area: but we do not object to the adoption of the name, on a far wider scale, if it can be advantageously introduced. We desire only to retain for the coal range, a name for which we confess we entertain great affection.

Certain of our American archæologists do, indeed, go a little further; they are so impressed with the fitness and comprehensiveness of the term, that the New York Historical Society has propounded, in all seriousness, the adoption of ALLEGHANIA for the name of the whole Union.*

We now turn to more direct geological considerations. The Appalachian system as contemplated by Darby and his successors, comprises a vast series of parallel ridges, in advance, to the east and south-east, of our Alleghany region, and includes not only the bituminous coal-field of the latter, but nearly every known American rock formation, from the new red sandstone down to the granite. It comprehends the whole carboniferous group; the anthracite basins of Pennsylvania, and the bituminous coal-field of the Alleghanies; the subjacent Devonian system; and, beyond this, the entire Silurian series and palæozoic rocks, and finally the primitive group.

In physical geography, the arrangement is wholly unobjectionable:—as applied to geology, it seems to be too indefinite, and suggests the subdivision of its members.

The distinguishing geological characteristics of the Appalachian system have been traced by the Messrs. Rogers, with a masterly hand.† Every one who seeks to know something of the physical topography of the most valuable and remarkable portion of the American continent, cannot fail to derive advantage from the perusal of this lucid exposition.

* A Report of the Historical Society of New York, dated 31st March, 1845, contains the following resolution: "That the name of '*Alleghania*' be recommended as the best, considering that it is derived from the grandest and most useful natural feature, common to the whole country; an eternal type of strength and union; stretching from the gulf of Mexico to the great lakes;—that it is associated with the most interesting portions of our history; and that, in adopting it, we should restore to the land one of the primordial titles of the aborigines."

† On the Physical Structure of the Appalachian chain. Trans. of the Association of American Geologists. Vol. I. p. 477. 1843.

THE ALLEGHANY, APPALACHIAN, OR ENDLESS MOUNTAIN COAL-FIELD,

DESCRIBED ACCORDING TO ITS EIGHT PROVINCIAL DIVISIONS.

This magnificent coal-field traverses eight of the principal states in the American Union. In the greater part of these states, geological surveys have been in progress, for a number of years; and periodical or preliminary reports have, from time to time, been submitted to the legislatures of those states respectively, by the surveyors. In but a very few of them, however, have the final details of the survey; the engraved and geologically coloured maps; and the various essential illustrations, incidental to the whole work, been published. The design, therefore, of these geological investigations, has but very partially been carried out, on account of the alleged expense; a failure which is much to be regretted. We may add, that our own labours in preparing this part of the present volume, would have been greatly curtailed, had those geological surveys been brought to maturity.

DIMENSIONS.

The greatest length of the entire coal-field, measuring along its centre,	750	miles.
The greatest breadth,	173	"
The average or mean breadth,	85	"

By the computation of Professor Mather, the area, in round numbers, is 50,000 square miles.* In calculating the actual size of this region, we have comprised within its limits those rocks which, by every geologist, are associated closely with the coal; that is to say, the sandstones, conglomerates, shales; the argillaceous slates, and occasionally the intercalated limestones, which combine to make up the series usually called the coal measures or carboniferous strata. From this maximum superficies, we have made no deduction for accidental areas, occupied by inferior formations; such, for instance, as are brought to the surface by one or several anticlinal axes. We have reason to know that the aggregate of these interposed areas is considerable. Neither have we made allowances for the numerous cases of denudation; for the partial removal of large areas of coal strata;—for the wide and deeply indented valleys; or for the innumerable ravines which cut away the productive strata, leaving large unprofitable areas. It is unusual to enter into such details; yet if they were investigated and computed, their aggregate would bring down the result of the available or productive areas to an unexpected degree. We know of vast bodies of so-called coal

* Second Geological Report of Ohio, p. 7. 1838.

lands, within this field, that have scarcely the tenth acre really productive in that combustible, through a combination of the circumstances just alluded to. Our estimate of the Alleghany coal-field is, for this reason, an extreme one, yet we believe it is strictly correct as to the general superficies.

Taking, therefore, for our principle of admeasurements, the areas in question in their most enlarged sense,—the gross rather than the nett returns, if we may so speak,—we find the areas of the provincial divisions of the Alleghany bituminous coal-field, to be as follows, in round numbers:

	States.	Area of the Whole State. McCulloch.	Area of Bit's Coal Strata therein.
		Square Miles.	Square Miles.
I.	Alabama, - -	51,770	3,400
II.	Georgia, - -	58,000	150
III.	Tennessee, -	45,000	4,300
IV.	Kentucky, -	40,500	9,000
V.	Virginia, - -	64,000	21,000
VI.	Maryland, -	13,950	550
VII.	Ohio, - - -	44,400	11,900
VIII.	Pennsylvania,	47,000	15,000
	Total,	364,620	65,300

NOTE.—The older returns of the respective areas of the States give larger results than those published by S. A. Mitchell, in 1836 and subsequently. These returns, therefore, make the aggregate of the seven states in the adjoining column, 350,449 square miles, instead of 364,620 square miles; the former being probably the more accurate.

Since completing this computation, we have observed that Prof. H. D. Rogers has calculated that the superficial area of the Alleghany coal-field "upon a moderate estimate, amounts to sixty-three thousand square miles."*

Were we to make the deductions for unproductive areas, for erosions of strata, and for such coal beds as are never likely to be reached by the miner, it would perhaps be a liberal estimate to rate the workable area of the whole at forty thousand square miles.

Even on this principle, we have here in this field, no less than 25,600,000 acres of productive coal: an enormous aggregate, of whose ultimate value no present estimate can be formed—no array of figures or of words can adequately portray.

It is beyond the scope of human vision to contemplate, in our day, the results associated with these millions—the industrial facilities, the wealth, and power, and influence at home and abroad, which they must inevitably confer upon the future inhabitants of the country.

* Trans. Assoc. American Geologists and Naturalists, vol. i. p. 436.

LOUISIANA.

It has been very recently announced in the south, that bituminous coal has been discovered *in situ* on the Iberville river, and in sufficient quantity to supply the ordinary demand for coal in this part of the country. Should the report prove correct, of which we entertain some doubts, the existence of the coal formation, or an insulated portion of it, prolonged in the range of the main coal-field of the United States, to a point so near the Gulf of Mexico, is not alone a highly interesting geological fact, but a very important one as regards the coal statistics and the mineral resources of the southern portion of this country.

Another report [1847] is of a species of coal, found, it is said, on the shores of Lake Bistineau, on Red river, and which is proved to be adapted for the forge or grate. This lake is bordered by a sandstone, over which fossils are described to be deposited, and fossil wood: tertiary lignite?

Again, another announcement [1847] is of coal at Lake Borgne, below Lake Pont Chartrain; probably carbonized wood.

The bulk of the coal which is consumed along the southern shores of Louisiana and Alabama, is not derived from resources existing within the latter state, but has descended from remote places high up the Mississippi and the Ohio rivers, or by the circuitous navigation of the Tennessee, the Cumberland, and other rivers, which originate to the northward of Alabama.

For want of railroad and canal facilities for transportation to the south, the exports of north Alabama, amounting to about one-fourth the products of the state, are now transported along the rivers we have mentioned, to New Orleans, a distance of from fifteen hundred to seventeen hundred miles.*

The bituminous coal which arrives at New Orleans and Mobile, is sold by a local measure called a barrel, and not by the ton weight, or by the bushel or the chaldron, as in other parts of the United States. Thirteen of these barrels are estimated to be equivalent to one ton.

The following statement from the local commercial returns, exhibits the number of barrels, of western bituminous coal, sold in the port of New Orleans, annually; the fiscal year commencing on the first of September. The prices are very fluctuating: we have seen coal quoted as low as 75 cents, and as high as $1 25 per barrel: the average is not far from 80 cents; average for 1847 is 75 cents per barrel. The increased demand is very great of late years, as seen in the table below.

Years.	Barrels.	Years.	Barrels.	Years.	Barrels.	Years.	Barrels.
1830	40,800	1838	99,220	1843	255,568	1847	356,500
1832	50,000	1840	99,915	1844	227,788		
1834	65,100	1841	121,233	1845	281,600		
1836	85,328	1842	140,582	1846	262,800		

* Report on the Alabama, Florida, and Georgia Railroad.—*Campbell.*

We add here, from a late report of Colonel Abert, of the United States Topographical Engineers, a few notes on the internal commerce of New Orleans, in 1846.

Value of commerce of western rivers with New Orleans, -	$ 9,737,354
Exports and imports of New Orleans, in 1842, officially, -	50,566,903
" " " " 1846, " -	62,206,719
Natural internal water-courses in communication with New Orleans,—miles, - - - - - - -	16,674
Population of internal water-courses in communication with New Orleans,—persons, - - - - - -	8,877,456

I. ALABAMA DIVISION.

BITUMINOUS COAL AREA, THREE THOUSAND FOUR HUNDRED SQUARE MILES.

Respecting this, very little is known; no geological or official investigation has been made that we are aware of.

The fossil coal plants of Alabama, were, subsequently to the date of Mr. Lyell's paper, submitted by him to the inspection of Mr. Bunbury, who identified several of these vegetable remains with well-known European fossils. Out of sixteen species thus examined, one half agreed with the plants of the old carboniferous formation in Europe, and the rest belong to genera which are common in the English coal measures. Thus, at the distance of nearly five thousand miles, [the broad Atlantic now intervening] we observe a new proof of the wide extension of a uniform flora in the carboniferous period.*

The *manufacture of Iron* is steadily increasing in Alabama. Vast quantities of ore occur in Tuscaloosa county.

COAL-FIELD OF TUSCALOOSA.

Under this title Mr. C. Lyell has described the southern part of the Alleghany coal-field.† We derive the following abstract from that account as published in Silliman's Journal.

The city of Mobile is supplied with bituminous coal for fuel and gas, chiefly from this coal-field, by means of the Tombecbee river; a navigation of more than three hundred and fifty miles. Mr. Lyell, had at first suspected from various circumstances, that this deposit might be related to the Richmond coal in Virginia, which has been shown to be of newer date than that of the Alleghany range. This impression was, however, entirely removed on inspection of the district in question.

The coal seams are worked in open quarries, where the outcrops of several seams are dug successfully; the quality being good. They are covered with beds of the ordinary black, carbonaceous shale; full of impressions of more than one species of calamite; with Pecopteris and Neuropteris, Sigillaria and Lepidodendron, and occasionally Stigmaria. The perfect identity of these coal plants with those of Europe, of Ohio and Pennsylvania, was recognized. They also differed essentially from the vegetable remains that are most abundant and characteristic in the newer coal-field of Richmond.

The strike of these coal beds of Alabama, on the Warrior river, and to

* Proceedings of the Geol. Soc. August 1, 1846.
† Silliman's Journal, May, 1846.

the eastward, is north-east and south-west; agreeing with the general direction of the Alleghany Mountains, of which they are, geologically speaking, a southern prolongation, and are bent into anticlinal and synclinal ridges, similar to those of the Alleghanies.

The carboniferous strata here appear to come into direct contact with the cretaceous rocks. The productive coal measure seen by Mr. Lyell on his tour, consisted of the usual sandstones, shales, and clays, with seams of coal; the thickest seen by him being about four feet; but a ten foot seam has been discovered further to the north than the localities he visited. This carboniferous formation is many hundred feet thick; succeeded by a great series of gritstones; and thence passes downward into thinly laminated sandstones and dark slates.

Under this carboniferous group lies a limestone formation, with much intermixed chert and hornstone. In the pure limestone, which is fetid, no fossils occur; but in some of the associated siliceous beds, fossils abound, apparently those of the mountain limestone. Throughout the entire range of the inferior limestone, occurs an enormous mass of brown hematite. "From the accessibility and richness of this ore, its proximity to the coal-field, and to the navigation of the Tombecbee river, I can hardly doubt that, like the coal itself, it is destined, at no distant day, to be a source of great mineral wealth to Alabama."

A brief account of this coal region was published by Professor Brumby, in Barnard's Almanack, for 1838. It is impossible to determine the number and thickness of the seams of bituminous coal, as no regular survey of this state has been commenced.

Mr. Lyell adds, that the fossil plants of Alabama, situate in latitude 33° 10′ north, form a subject of peculiar interest; being apparently the extreme southern limit to which the peculiar vegetation of the ancient carboniferous era has yet been traced, whether on the western or the eastern side of the Atlantic.

On this point, however, we believe we shall be able to show an extension of the true coal formation much lower south than the Tuscaloosa coal, at 33° 10′. Coal and anthracite are reported at a number of points in Texas, stretching in a south-west direction across the headwaters of the Trinity, the Brassos, the Colorado, and other rivers which empty into the Gulf of Mexico, and even crosses the Rio Grande into Mexico, below the latitude of 28°. More than this, we know that coal is worked at Guerrero, on the river Salado, for the use of the American steamers on the Rio Grande, in N. latitude 27°—being six degrees lower than Mr. Lyell's extreme southern limit.

II. GEORGIA DIVISION.

We possess no details of this small angle of the coal formation. It probably does not comprise more than one hundred and fifty square miles of bituminous coal area, and was, until a few years back, owned by the Cherokees.

III. TENNESSEE DIVISION.

This part of the Alleghany range, occupies an area of 4300 square miles, the greater part of which consists of the elevated local group known as the Cumberland mountains.

The geological survey of this state has, during many years, been confided to the charge of Professor Troost, who has communicated to the General Assembly of Tennessee, a series of eight periodical reports, between the years 1831 and 1846. Those which more especially refer to the coal region, are the third, dated October, 1835, and the eighth, dated in November, 1845, but they contain very few practical and economical details respecting mineral coal.

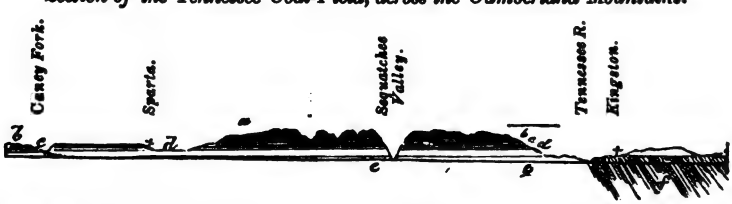
It is understood that West Tennessee has received some investigation from Dr. D. D. Owen, and that the Messrs. Rogers have made some reconnoissances in East Tennessee; but as none of these have, we believe, been published, we are precluded from the advantage of citing the geological results ascertained by those indefatigable investigators.

From the maps which accompany the state annual reports, we perceive that the boundaries of the coal formation are singularly irregular; occasioned by the numerous projecting spurs of the Cumberland mountains, forming alternate bays and promontories, on their western flank. These maps are exceedingly coarsely executed, and do not afford the details we could have desired. We are unable to collect much statistical information from the published reports and maps, respecting the number or thickness of the several coal seams in this section of the great coal-field. In the first report they are somewhat vaguely alluded to as "several outcrops of horizontal strata of great extent." In no instance, in that report, are the respective thicknesses of coal beds recorded; nor can we form any opinion of the amount of the production or consumption of coal, within the district. The quality of this coal is, however, spoken of as excellent. Analyses of two specimens are furnished by the geologist, whence it appears that the coal here approaches in character to the semi-bituminous variety in Pennsylvania and South Wales, and that it possesses only from fourteen to seventeen per cent. of volatile matter.*

The following Section we have compiled from data furnished by Prof. Troost:

Fig. 1.

Section of the Tennessee Coal-Field, across the Cumberland Mountains.



Scale 20 miles to an inch. *75 miles.*

a a *Coal Measures, almost horizontal.*
b b *Cherty Sandstone, with Iron Ore.*
c c *Bituminous Shale.*
d d *Mountain Limestone—Oolitic above.*
e e *Old Red Sandstone.*
f *Upper Silurian rocks, probably broken by parallel axes.*

* See the Tables of Analysis at the end of this work.

It is evident that much remains to be done in Tennessee, in the way of geological elucidation, and the development of the coal and iron of the state. We believe, however, that very little progress has yet been made in coal operations, or in any branch of mining industry, and, consequently, that opportunities for examination in so wild a region, were rarely afforded to the geologist. He observes, that the deposits of coal in southern and central Tennessee, are evidently of great extent, and are, as yet, only partially brought to light; while those that are best known are only slightly penetrated. Most of them, in fact, have done nothing further than merely to furnish the fuel for the blacksmiths of the surrounding country.

Notices of a great many coal seams appear in the eighth report; but the continuity of these has been so little made out, that there are, at present, no means of determining their number and continuity, so as to be able to recognize them in other parts of the region. The geologist enumerates several beds, of two feet, three feet, and four feet, in thickness; one of six feet, another of eight feet; one of twelve, and a large one of twenty feet. These are all described as good coal, with various qualities and adaptations.

The reporter concludes with the observation, that there exists an inexhaustible treasure of this combustible; which, if once the means of transportation are established, by a railroad, will make Middle Tennessee entirely independent of the uncertain water communication which is generally unavailable here during the summer season, and may be the means of transforming this portion of the state into a manufacturing country.*

In the vicinity of the Cumberland mountains a considerable quantity of coal is consumed in the iron works. Some is also transported to distant iron works, and another portion descends the Tennessee and Cumberland rivers, and thence, circuitously, by the Mississippi to New Orleans and the intervening towns, and even to Mobile. At the Dover iron establishment in Cocke county, East Tennessee, the proprietors bring from the coal region a hundred thousand bushels per annum.

According to the third report of the state geologist, this coal is shipped from various points, but particularly from near Kingston; from whence it passes down the Tennessee river more than six hundred miles to the Ohio, and thence, more than a thousand miles further, to New Orleans; making a voyage of no less than *seventeen hundred* miles of inland navigation.† From the western margin of the Tennessee coal-field, a certain quantity of coal is sent down the Cumberland river, nearly an equal distance, to its place of destination.‡

In the eighth annual report, Dr. Troost states that, in 1845, only a few loaded boats descended the Tennessee river, some of which reached New Orleans; but as that city is now much more conveniently supplied from the Ohio river, although quite as long a voyage, he thinks it doubtful as to the future descent of the Mississippi river for Tennessee coals. There is a project under consideration, and urged by the state geologist, for making a railroad from the southern border of Tennessee, near the Georgia line, across the coal-fields of the Cumberland mountains, to Nashville; a measure which would greatly favour the interests of a large area of coal land.

* Eighth Geological Report of Tennessee, p. 15.
† Third Report to the Legislature of Tennessee, by Gerard Troost, M.D. 1840, p. 4.
‡ Report on the Alabama, Florida, and Georgia Railroad, 1838, p. 6.

PRODUCTION.

We will not quote the congressional return of bituminous coal mined in this state, in 1840, because it is obviously incorrect. The report of the Secretary of the Treasury, on the domestic products of the United States, of the 6th January, 1845, is still less entitled to credit; being yet more meagre and incomplete than the other.

Like the other coal-fields of this country, that of Tennessee has contributed very little of the ore from which iron is smelted. This is owing, probably, not so much to the absolute deficiency of the argillaceous carbonate of iron which usually accompanies the coal measures, but to the greater abundance, if not to the superior quality, of various other kinds of iron ore, which are distributed throughout the country. Those employed in the furnaces of Tennessee are the "Red Oxide," and the various "Hæmatites," and brown ores; and being smelted by the aid of charcoal, produce an iron of excellent quality.

NORTH CAROLINA.

We have no authentic knowledge of the bituminous coal in this state, but anthracite to a very small amount is raised here. The return to Congress in 1840, on which, by the by, little reliance can be placed, shows only fifty tons in that year, and seventy-five bushels of bituminous coal.

Bituminous coal occupies a detached basin on the borders of the Roanoke, and near the state line adjoining to Virginia, in Rockingham county.

Another small basin is situated in Chatham county, in the centre of this state, ten miles south of Pittsborough. This bituminous coal is described as occupying a thin bed, and at present is not worked to advantage.

Other insulated patches of coal are stated to exist in the same range, but, to the present time, little or no advantage has been taken of the presence of this invaluable mineral combustible in various districts of this state.

IV. WESTERN VIRGINIA.

VIRGINIA DIVISION OF THE ALLEGHANY COAL-FIELD.

We have previously assigned for the space held by Virginia, no less than twenty-one thousand square miles. Of this enormous area the actual amount of coal land now in profitable operation is comparatively small. Large bodies of land on the western slope of the Alleghany range, descending to the Ohio, still continue unsettled, although there is, at the present moment, a current of emigration setting in that direction, and a strong impetus is evidently given to industry and improvement in a heretofore much neglected district.

Dr. S. P. Hildreth, in an unusually long and elaborate article in Silliman's Journal of Science, a few years ago, furnished numerous illustrative details of the coal strata in the western borders of this state.

This communication, made under some disadvantages in a scientific point of view, was quickly followed by a series of reports from the able geologist appointed to that service by the state.* These have placed a large mass of useful geological information before the public; although, as relates to statistics, they are somewhat less copious.

It will be observed, on reference to the tables of analysis in our Appendix, which we derive almost solely from the state reports, that the western coal seams are much more bituminous than the eastern. These western coals contain nearly equal proportions of volatile matter and carbon, and belong strictly to the class denominated *Fat*; *adhesive*, bituminous coals.

At Wheeling, and for fourteen miles down the Ohio, the cliff or bank of the river presents an uninterrupted bed of highly bituminous coal, about ten feet thick.† This seam, with some other smaller ones, constitute Prof. W. B. Rogers's "Upper Coal series," and extends from Pittsburg, southward to Clarksburg, in the parallel of Marietta; and, according to Prof. H. D. Rogers, does not extend beyond the Guyandotte river.

Along the valley of the Monongahela are several fine beds of coal. One of them distinguished as the "Pittsburg seam," is the ten feet bed before spoken of, which, to some, is known by the name of the "Main Coal" of northern Virginia, and is readily recognized where it crosses the Great and the Little Kanawha rivers, and thence to the Big Sandy river, on the borders of Kentucky.

The greatest thickness of workable coal is stated to be nine and a half feet, at the mouth of Scott's Run. The second coal seam in importance, is about five feet thick. A third is from three to four feet. A fourth, geologically the highest known coal bed of any value in Virginia, Pennsylvania, and Ohio, is five feet in thickness.‡

* The Act passed in 1835; the "Report of the Geological Reconnoissance," appeared in 1836, and a geological survey of Virginia, was officially directed to follow that Reconnoissance.

† Hildreth—in Silliman's Journal, 1835.

‡ State Geological Report, 1840, p. 86 to 92, by Prof. W. B. Rogers.

On the Great Kanawha are large developments of bituminous coal, as may be inferred from the foregoing paragraphs.

The workable coal seams in the upper group, are thus enumerated by the State geologist.

	Feet.
The first, or main seam,	5 to 9
Second "	3½
Third "	5½
Fourth "	7
	25 feet workable and one vein not workable.

Besides beds of limestone, amounting to fifty feet thick.

The middle division, or group, contains five feet coal in three beds, and twenty-four feet of limestone, in eleven beds.

The lower coal group contains five small seams, whose aggregate is but nine feet, only one bed of which is workable.

It would seem, therefore, that of these thirteen coal beds, having an aggregate thickness of forty feet, four seams, comprising eight yards of workable coal may be relied upon, through nearly the whole length of the state, as the productive power of Western Virginia.

For the analysis of the coal of these seams, at various localities, we refer to the tables at the end of this book; they are derived from the State Reports.* We regret our not having the advantage of quoting the final report of the scientific gentlemen at the head of this department.

In 1835–6, it was stated that in the salt region of Western Virginia there were ninety establishments, producing one million bushels of salt annually, and consuming 5,000,000 bushels, or 200,000 tons of coal.†

In 1840, the amount of bituminous coal mined in the Alleghany, or western counties, was returned at 298,698 tons of twenty-eight bushels. The aggregate of coal, at that time produced in all Virginia, was 379,369 tons—which is probably less than the actual amount—would be about equivalent to nine acres annual consumption from the upper group of workable coal beds, in Western Virginia. The number of workmen, or miners then in employ, was nine hundred and ninety-five, and the capital so engaged was estimated at $1,301,855.

These Congressional Reports so abound in discrepancies as to materially impair their usefulness. For instance, Pennsylvania, which makes a larger return than Virginia, viz. 415,023 tons of bituminous coal, employing one thousand seven hundred and ninety-eight miners, rates the capital invested at only $300,416. The results of that inquiry (Congressional,) are really so vague, that we can venture to draw no inferences from them.

CANNEL COAL.

Near Charleston, Kanawha County, a bed of this description of coal has been subjected to experiment, with satisfactory results. Its range is apparently of considerable extent.

* Report Geol. Surv. of Virginia. 1840.

† Records of General Science. Vol. V. 1836. Also American Journal of Science. Vol. XXXIX. 1836.

The northern extremity of Virginia corresponds, in respect to number and quality of its coal beds, with those to which we are enabled more particularly to advert in the State of Maryland.

At the position overlooking the Potomac Valley, called Brandt's Mines, there are described five workable beds, from three feet to fifteen or more feet thick each, or thirty-five feet in all.*

IRON MANUFACTORY OF WESTERN VIRGINIA.

This is of growing importance, but our details are scanty.

WHEELING.

The following is a statement of the annual products of the Iron business, for the years 1845 and 1846, showing the increase of business in that branch.

	1845.	1846.
Iron Works at Wheeling,	$300,000	$435,820
Foundries,	74,000	99,000
Engine building,	60,000	96,000

On approaching the eastern margin of the great coal-field, it has been found that the prevailing quality is much less bituminous there than near its opposite margin.

Immediately west of the escarpment of the great Alleghany ridge, in Hampshire county, are parallel and nearly horizontal coal seams, extending along the borders of the Potomac; five of these are of workable thickness, the aggregate being about thirty-five feet thick.

* Charles Kinsey's Letter to the Union Potomac Company.

EASTERN VIRGINIA.

SMALL DETACHED AREAS OF ANTHRACITE AND SEMI-BITUMINOUS COAL.

For some years it has been known that here and there a few patches of coal occur in the mountain ranges which run parallel with the eastern base of the Alleghany mountains. In Berkley county, a few developments of excellent anthracite in a ridge near Martinsburg, led to the formation of a working company, some years ago.* The undertaking failed, it is understood, on account of the deficiency of the supply of coal. In several other counties, along the same range, which corresponds with that of Schuylkill county, similar anthracite traces prevail, although of inconsiderable value.

Other localities occur in this parallel in which coal of the semi-bituminous species appears. The seams of this coal vary from three to seven feet in thickness, in Botetourt and Montgomery counties, in the Little North mountain.† Their analysis, which will be found in the tables at the end of this work, shows them to resemble the coal of the Round Top mountain, in Pennsylvania.

Only two hundred tons of anthracite were returned as the production of Virginia in 1840.‡

RICHMOND OR CHESTERFIELD BITUMINOUS COAL-FIELD.

This is an area which has been longer known and worked than perhaps any other in the United States. The geological map of McClure—the father of American geology—was prepared to illustrate his memoir in 1817. In position and form, as there represented, this coal-field differs in no material respect from the maps of the present day—and thirty years of operations there have not greatly enlightened us as to its details.

Mr. Nuttall, in the Journal of the Academy of Natural Sciences, of Philadelphia, some years ago, furnished a short notice of the vegetable fossils which characterize the shales of this coal basin, and adverts to the vestiges of fossil fishes which had already attracted the attention of previous naturalists.§

Some reference to these Virginia coal plants may be found in Sternberg;‖ but Mr. Nuttall was the first to point out the prevalence of certain fossil vegetables, which seemed to confer a peculiar character on the formation, although the value of such a test was probably unknown to, and unsuspected by the observer of those days.

M. Adolphe Brongniart has figured and described some coal plants from hence, considering them as belonging to the true carboniferous period.¶

* Memorial of the Baltimore Convention to the Commonwealth of Virginia, 1834.
† Report of the Geological Reconnoisance of Virginia, p. 90.
‡ Congressional Report on the Census, 1841.
§ Journal Acad. Nat. Sciences. Vol. II. p. 36.
‖ Sternberg. Book III. p. 16. 1826.
¶ Histoire des Vegetaux Fossiles, p. 126.

The author of this work, in 1834, addressed a memoir to the Geological Society of Pennsylvania, respecting a portion of this coal-field. This paper was accompanied by several diagrams, among which was a vertical section of one of the deep shafts, the first illustration of this description, that the coal-field had received.* This communication was followed by another from Mr. Clemson, on the analysis of the coal collected from several of the mines on each side of the James river.†

In the same year a brief account of this basin and its coal trade was given in a Report to the Senate of Pennsylvania.‡

In 1839, a concise description of the same district appeared in an able Report of the Committee on a National Foundry, ascribed to the Hon. W. Cost Johnson. It also refers to a document, submitted at a public meeting at Richmond, February 6th, 1838, wherein it is affirmed, "that every cannon foundry in the United States is furnished with coal from the Black Heath pits, and that other pits supply large quantities to the northern iron factories."§

The Richmond coal basin has generally contributed the principal supply to the gas works at Philadelphia, for which it is well adapted.

The geological age of this coal-field has been a subject of some investigation, owing to the anomalous character of the beds of shale and sandstone which overlie the coal. These differ entirely from those of the regular coal series in other parts of the American Continent. Those occupied by shale are distinguished by peculiar fossils. The numerous suite of interstratified rock beds consist of granitoid sandstones, or *psammites;* derived from the destruction and reproduction of the primitive rocks in which this basin is placed. A rock of precisely similar appearance, crosses the Schuylkill from seventeen to twenty miles above Philadelphia; the resemblance being so close as to show no distinguishable difference in hand specimens. The sandstones of some coal-fields on the European Continent are of this character. The coal of the basin of Blanzy, in France, occurs in a gneiss valley, and alternates with granitoid psammites. That of Fins et Noyant, also in France, reposes upon granite; and that of Ahun consist of strata which are recomposed from the debris of granitic rocks. Near Oporto, also, anthracite occurs, interstratified with granitoid psammites, overlying primitive rocks, and covered by chlorite slate. In Northern Bengal and Bhotan are similar granitoid sandstones, containing brown coal.

During a transient inspection of these strata, in 1834, it seemed to the present writer that the series was at least contemporary with the ordinary coal measures. Perhaps the well known presence of the fossil *Calamites Suckowii*—recognized by A. Brongniart himself from hence‖—a species common to the anthracite shales of Wilkesbarre, to the lowest bituminous shales of Continental Europe, and to the old coal measures of England and Wales,¶ contributed to this impression.

Subsequently, the vegetable fossils of these remarkable strata have been maturely investigated. To the fossil fishes have been applied the test of modern science; and the opinion is now settled that we must look to a later period than that of the carboniferous era for the origin of the Chesterfield deposit.**

* Trans. Geol. Soc. of Penna. 1835. Vol. I. p. 275. Pl. 16. † Ibid. p. 295.
‡ Senate Journal. Vol. II. 1833–4, p. 567.
§ National Foundry Report. Doc. No. 168, p. 41.
‖ Histoire des Vegetaux Fossiles, p. 126.
¶ Count Sternberg. Book IV. p. 16. 1826.
** Proceedings of the Academy of Natural Sciences, January 1842.

In 1843, appeared a memoir "on the age of the coal rocks of Eastern Virginia," by Professor W. B. Rogers, which has thrown additional light on this interesting subject. We will briefly endeavour to convey the author's views and the testimony which appears strongly to sustain them. Abundant evidence, of a satisfactory character, is produced, of the geological peculiarities of the numerous series of beds which overlie the thick deposit of coal here. This bed is of irregular thickness, in consequence of the uneven surface of the primary rock on which the coal was deposited, by which, at certain points, it is only a very few feet, and at others deepens to upwards of orty feet. The author assigns for this coal the same geological age as that of the shales and granitoid sandstones overlying it. The entire group presents, it is conceived, striking analogies, in its vegetable remains, to the oolite coal formation of Brora, in Scotland; of Whitby, in Yorkshire; and of certain other European localities. Some of these plants appear to be specifically the same as the English fossils of that epoch; while the rest are very closely allied to certain species of the same genera found in connection with the oolite coal of Yorkshire and Sutherlandshire.

It is to be regretted that no figures of these fossils illustrate this able paper, the value of which would have been greatly enhanced by such essential aids. Nevertheless, the elaborate descriptions of the plants from the coal shales are decisive, in most instances. The fishes, mentioned many years ago by travellers and geologists, have been fully investigated and named by Mr. W. C. Redfield, and go far to settle the point.

These facts seem strong enough to justify the referring this coal-field of Eastern Virginia, to a place in the Oolite system, on the same general parallel with the carbonaceous beds of Whitby and Brora,—that is, in the lower part of that group.*

We have to add, in corroboration of these views, that, at a meeting of the British Association, Sept. 1846, Mr. Lyell stated that he had lately examined this coal-field, and had submitted some of the fossil fishes, obtained from it, to M. Agassiz, which he referred to the Oolite period. The fossil plants, likewise procured from hence, were examined by Mr. Bunbury, who considers that they present an assembage which agrees with those found at Whitby in Yorkshire, and therefore of the Oolite period. This coal-field, consequently, is newer than that of the true carboniferous formation.

We must not forget, however, in relation to priority of observation, that Mr. Nuttall had long ago, recognized among the fossil plants of the coal-shales here, the *Zamia* or *Cycas*, and the leaves of one of the *Scitamineæ*, similar to those of *ginger*, and some enormous flaccid-leaved gramineous plant; all of which are characteristic of the Oolite period, although not so applied, at the time, by that intelligent naturalist.†

We rejoice to perceive this triumphant application of the test of organic remains, in determining otherwise very doubtful points as to the age of rocks; a principle which, some years ago, we, with all the partialities of an original disciple of William Smith, almost feared, was not appreciated as it deserved.

Whether the entire body of the coal itself be referable to this epoch is by no means settled. It has been suggested that the fossils above-mentioned, and seen at some of the pits, represent "a distinct formation of coal from

* Trans. Association of Amer. Geologists. Vol. i. p. 308. Also the State Report for 1840. P. 36.

† Journal of the Academy of Natural Sciences of Philadelphia, Vol. II. p. 36.

the main or true carboniferous formation, and many suppose it a deposit of after date."*

On the 14th of April, 1847, a paper was read before the Geological Society of London from C. Lyell, on the Richmond coal-field of Eastern Virginia. It is stated that the shells in these coal measures consist of countless individuals of a species of Posidonomya, much resembling the P. *minuta* of the English Trias. The fossil fish are homocercal, and differ from those previously found in the new red sandstone, [Trias ?] of the United States. Two of them belong to a new genus, and one to *Tetragonolepis*, and are considered by Prof. Agassiz and Sir P. Egerton, to indicate the Liassic period.

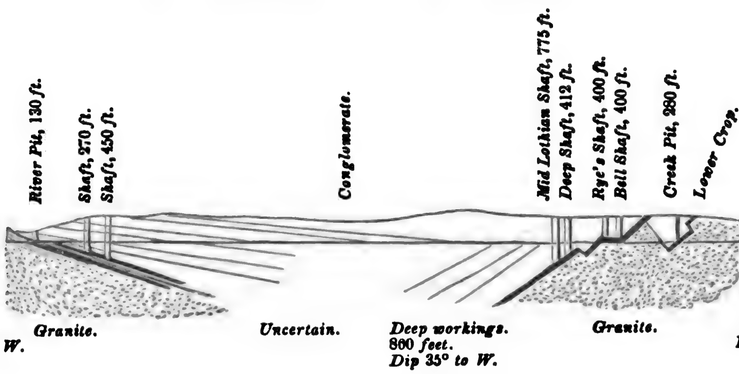
In the charcoal Dr. Hooker detected vegetable structure, not of Ferns or Zamites, or any Conifer, but perhaps of Calamites.

Mr. Lyell considers this coal as of the age of the inferior Oolite, or the Lias.

The fossil plants of the Richmond coal field have been also carefully examined by C. J. F. Bunbury, Esq. Fifteen different forms are described; of which, however, only ten are sufficiently well preserved to be determined with the requisite precision. Six of them are ferns; of which three are new species; one of them being identical with a species characteristic of the Oolites of the Yorkshire coast. One species of Equisetum, undistinguishable from that of Whitby; one or two Calamites; two of Zamites. Mr. Bunbury thinks that the Richmond coal-field is of later date than the great carboniferous system, and that it must be referred either to the Jurassic or the Triassic series,—more probably to the former.

Fig. 2.

Section of the Bituminous Coal Field near Richmond, Va.



We have seen no satisfactory announcement of the superficial area of this basin, and from local circumstances, it is not very readily defined. It has been considered as thirty or thirty-five miles in length, having a maximum breadth of eight, and an average of five or six miles. The state report of 1840 estimates the length at thirty miles. We believe that we shall not err greatly in assigning one hundred and eighty-five square miles as the extreme productive area of the Chesterfield basin.

There exist, probably, no data by which the depth to which the coal

* Silliman's Journal. July, 1842, p. 9.

descends in this trough, can at present be ascertained. The outcrop, on the eastern margin, rises at a much higher angle than that on the western. In the former, the shafts are far deeper than any others in America. The vertical section published by the Geological Society of Pennsylvania, in 1835, is by no means the deepest in the district, for there are other pits which are placed at a greater distance from the outcrop of the great mass of coal. Reid's deep pit at Chesterfield, to which we refer, measures four hundred and twelve feet, from the surface to the granite floor. The following summary shows the number of seams of rock, sandstone, shales, and coal, which were penetrated by this shaft. It is to be observed, however, that as the strata were not intersected at right angles, but at the inclination at which they were cropping out to the surface, they are proportionately and individually of greater thickness, as represented in the table, and traversed by the pit, than in strict accuracy, ought to be assigned to them.

The entire series, so far intersected, comprises ninety-four beds. Forty of these, consisting of varieties of carboniferous, micaceous and argillaceous shales, occupy an aggregate of one hundred and thirty-four feet. Fifty-one other strata consist of granitoid psammites, carbonaceous sandstones, white or gray micaceous grits of various degrees of texture ranging from conglomerates up to schistose sandstone, and comprise a thickness of two hundred and sixty-seven feet. At the base of the group are two or three coal beds with intermediate shales; the whole embracing a thickness of from eleven to forty feet of coal, and even fifty feet, according to the irregularities in the granite floor.

As before stated, there are other shafts which reach the coal at a deeper part of the basin than at this point; and as the operations are carried down the slope of the main seam, the works are necessarily becoming deeper, and the coal is excavated and brought to the surface at a corresponding increase of expense. Up to the present time, we believe, the eastern outcrop alone is that which is almost exclusively wrought, and owing to the steep inclination of the coal measures, not to a greater breadth than from one half to three quarters of a mile. The general course of this eastern boundary is S. 24° W. or thereabouts, and every investigation shows the arrangement to be that of an extremely elongated trough, occupying a hollow in the primary rocks. In the workings examined by the present writer, the coal was only separated from the granite by a bed of about a foot thick, of porphyry.

Some of these deep mines contain a good deal of water, and are consequently attended with expense to keep dry; for as the structure of this trough precludes the possibility of draining and working by the economical system of adit levels or tunnels, all the water, as well as the coal, has to be elevated to the surface by machinery, and generally, by steam power. Other mines are comparatively dry, even in the vicinity of the wet shafts. This fact speaks conclusively as to the dislocated nature of the coal basin, near its eastern margin.

The Maidenhead or Heath's mines are remarkable for their dryness, and no water occurs in any of the workings: such, at least, was the case in 1835, at which time no steam engine was needed for pumping. Some portion of this freedom from water is perhaps attributable to the subsidence of old works.

The Black Heath mines were then on fire, and could not be worked.

The Bell workings had been on fire for twenty-five years, and the fire had advanced to the workings of the Rise shaft. They were all walled up.

No flame arose, but a hot, smothering fire continued, year after year, the heat from which was sensibly felt, at some distance.

Only one trifling accident, it was said, had, up to that time, happened from fire damp.

The Bell and Rise workings, of above four hundred feet depth, belonging to Mr. Mills, gave way on the Christmas eve of 1833. Being a holiday, it was fortunately the cause of saving the lives of a great many miners, who usually worked there, at all hours; and it is remarkable that not a single life was lost on that occasion, although a few workmen were still below, employed in pumping, when the alarm was given. On the succeeding morning, the course of all the underground workings could be traced on the surface, as on a map, by the lines of fissure, running in the same direction, and extending along the ground.

Explosions of fire damp have been of occasional occurrence in these mines. In March, 1839, an explosion occurred in one of Heath's pits, by which a number of lives were lost, chiefly of coloured miners, to the number of fifty-three out of fifty-six persons, who were then in the mine.

The shaft of the mine was seven hundred feet deep, and the falling in of the earth was so great, that suffocation must have ensued to all who escaped the fire. Explosions, we are informed, occurred several times in the Maidenhead pits, prior to this period, and on these occasions several men were killed and burned.

Great improvement in the system of ventilation have been recently adopted in these deep mines. The first accident, from this cause, took place about 1817: fortunately the explosion occurred when the miners were out at their dinner, about one o'clock, in the day.

In 1841, and preceding years, several accidents by explosive gas occurred in Wills's mines, by which some lives were lost, and several men were severely burnt.

In June, 1844, an explosion took place in one of the Black Heath pits, while four Englishmen and eight negroes were in it. According to the statements of the time, only one person of this party was taken out alive.

SUBTERRANEAN TEMPERATURE.

Prof. W. B. Rogers has communicated the result of a series of observations on subterranean temperature, in the Chesterfield mines. The conclusion arrived at is, "That from the *invariable* plane, downwards for many hundreds of feet, the temperature augments at the rate of one degree for every sixty feet of depth."* This result agrees with that recorded by Professor John Phillips, in determining the ratio of descending temperature in the deep mine at Monk Wearmouth, nearly sixteen hundred feet deep. In this case it was also determined that the temperature increased one degree for every sixty feet of depth.†

In the American Journal of Science and Arts, of July, 1842, is a "Geological and Statistical Notice of the Coal Mines in the vicinity of Richmond," by A. S. Wooldridge, President of the Mid Lothian Mining Company.

The principal mines then in operation, were those of the Maidenhead or Black Heath company, by several shafts which vary in depth from one hun-

* Trans. Assoc. American Geologists. Vol. i. p. 538.
† Philosophical Magazine. Dec. 1844.

dred and fifty to six hundred, and even to upwards of seven hundred feet. The coal from these mines is of good quality, and averages thirty-six feet in thickness.

To the north of these are Wills's pits. A shaft here is about four hundred feet to the bottom; from whence two inclined planes, following the slope of the seam, are conducted, so as to increase the depth of the mine, about three hundred feet more. The coal is here thirty feet thick.

The Gowrie pit is four hundred and sixty feet deep—the coal only six feet. There are various other workings in this region, the shafts of which vary from one hundred and fifty to four hundred feet deep.

The Mid Lothian Company's mines lie to the south of the Maidenhead mines. Coal was struck here in 1839, in a shaft, at the depth of seven hundred and twenty-two and a half feet. The coal was thirty-six feet thick, and the sump below the coal being sixteen and a half feet deep, the entire depth of the shaft is, therefore, seven hundred and seventy-five feet. The coal inclines to the westward at an angle of thirty-five degrees, and in some places is full fifty feet thick, owing to the uneven configuration of the bottom rock, as was observed in other places.

Mr. Wooldridge states that large quantities of inflammable gas are constantly thrown out from the coal in this mine, and great care is taken to prevent the disastrous consequences of an explosion.

Our limits do not allow us to follow the details further. It appears that many new collieries are brought into operation, and a number of others are either exhausted or have failed from pecuniary or other difficulties.

It seems almost certain that the bituminous coal of Richmond, being of an age not older than the Oolitic or Jurassic period, partakes inevitably of the defects of the coal of that period, and can never attain to the rank of the better class of bituminous coals in the United States, any more than the Yorkshire coals of the same age in England. Its chief excellence consists in being a good grate coal for domestic use.

PRICE OF COAL AT THE MINES.

The various circumstances attending the quality, locality, &c., affect correspondingly the prices, and render it unsafe to quote any statements, that may be considered as representing an average.

In 1836, it was stated that the coal proprietor could deliver coal at Richmond, twelve miles, at fifteen or sixteen cents a bushel, shipped on board. This appears to be a high estimate when compared with the Alleghany coal which is brought by canals, from two hundred and fifty to more than three hundred miles, and sold in Philadelphia for eighteen cents per bushel.

In 1838, in the National Foundry report, it was stated that "coal could be furnished and pay a reasonable profit to the collier, at ten cents per bushel on the north, and twelve and a half cents on the south, side of James' river, = $2.80 to $3.50 per ton.

In 1846, Richmond coal obtained from twenty to twenty-two cents per bushel, in Philadelphia, which was two or three cents per bushel higher than Alleghany bituminous coal.

The average annual amount of Richmond coal received in the port of Philadelphia, in the six years, from 1824 to 1829, was 124,305 bushels, or 4,143 tons.

The average annual amount imported into Boston during seven years, from 1835 to 1841, inclusive, was 162,552 bushels, or 5805 tons. The entire importation of American bituminous coal into Boston was diminished to little more than 4000 tons, in 1847.

QUALITY.

Some analysis of the Chesterfield coals will be found in the appendix. They were also subjected to the scrutinizing investigation of Prof. Johnson, in 1844. The number and species of American coals* experimented upon were about forty; and we find, from the tables of results furnished in the Report, that the Chesterfield coals, taken from four different pits, ranked as follows:

	Numbers.			
Rank in the order of their relative weights, - - - -	10	27	32	40
" " of rapidity of ignition, - -	8	13	16	20
" " of completeness of combustion -	6	12	16	28
" " of evaporative power under equal weights,	20	22	26	29
" " of evaporative power under equal bulks,	24	27	28	30
" " of evaporative power of comb'ble matter,	22	23	26	33
" " of freedom from waste in burning,	20	25	27	28
" " of freedom from tendency to clinker,	20	26	28	29
" " of maximum power under given bulks,	25	27	28	31
" " of maximum rapidity of evaporation,	1	15	26	39

CLOVER HILL COAL MINES.

In 1845, the Clover Hill Railroad Company constructed a road from a shipping point on the Appomattox river, near Fredericksburg, to what was then a new coal region, but is ascertained to be an extension of that which had been long known and worked, in a north-east direction. These mines are about fourteen miles south of the most southerly, previously wrought, and there is a space of ten to twelve miles between the two regions, in which no mines are yet opened, but in which the coal measures, and in fact, coal, is known to exist in greater or less extent, although it has never been explored. The general impression, among colliers, is, that the coal is co-extensive from one end of the field to the other, and some even extend their views further south, and place it in North Carolina, where coal is found west of Raleigh. The Clover hill portion of the field has been practically opened to commerce only during 1846 and 1847. The coal is not shipped at Richmond, but at twenty miles distant, near City Point, at the mouth of the Appomattox river. Consequently, it is not included in the Richmond returns, and the amount is additional to the Richmond reports.

We are informed by J. Hopkins, Esq., that since the completion of the road, up to the 1st October, 1847, there has been sent by railroad 2,187,000 bushels of coal, besides some sent by other conveyances; of which 1,592,830 bushels have been shipped for northern or southern ports; the remainder was consumed in Richmond and Petersburg. The business of 1847 is at the rate of 1,500,000 bushels or 53,500 tons, and is increasing. It will probably exceed 2,000,000 bushels or 71,000 tons in 1848.

* Report to the Navy Department of the United States on American Coals. By W. R. Johnson. 1844.

PRODUCTION.

In 1840, the congressional return of the annual production of this coal-field was 80,671 tons. By a subsequent return to the Virginia legislature, it appears that the quantity of bituminous coal raised here, between the years 1822 and 1841, inclusive, was forty-nine millions of bushels=1,750,000 tons, being at the average rate of 87,500 tons per annum, for twenty years. The expense of raising this coal was stated to be $1.12 per ton, or four cents a bushel.

Table of Annual Shipments of Virginia Coal,

From Richmond, exclusive of the home consumption. The original returns are in bushels, a pernicious custom which should be abolished, but for convenience of reference we have reduced them to tons of 2240 lbs.,* as in all cases where measures are quoted instead of weight.

Years.	Tons.	Years.	Tons.	Years.	Tons.	Years.	Tons.
1822	48,214	1830	91,786	1838	96,428	1841	71,071
1824	59,857	1832	117,857	1839	85,714	1842	65,750
1826	79,214	1834	110,714	1840	78,571		
1828	89,357	1836	110,714				

In 1847, the Clover Hill mines furnished at the rate of 53,000 tons a year, as before mentioned, in addition to that from the Chesterfield district.

Current prices of coal at Richmond, January 1st, 1848.†

Chesterfield coal, 10 cts. to 18 cts. per bushel—$2.80 to $5.04 per ton.
Best Clover Hill coal, 20 cts. " $5.60 "

IRON MANUFACTORY OF EASTERN VIRGINIA.

In the entertaining diary of Colonel Byrd, written between the years 1728 and 1736, but first printed in 1841, occur some curious and interesting details of the iron works of that period. There were, in 1732, four furnaces in Virginia; but at that time no forge had been erected in this colony; although a very good one was then in operation for making bar iron, at the head of the bay, in Maryland. "It was feared that the English parliament would soon forbid us that improvement; lest, after that we should go farther, and manufacture our bars into all sorts of iron ware, as they already do in New England and Pennsylvania. Nay, it was questioned whether we should be suffered to cast any iron, which they [the English] can do themselves at their furnaces."

Colonel Spotswood, who furnished Colonel Byrd, in 1732, with much practical information, was not only the first in Virginia, but the first in North America, to erect a blast furnace [about 1715.] He stated that "they ran, altogether, upon bloomeries in New England and Pennsylvania, till his example had made them attempt greater works. In the latter colony,

* Register of the Treasury. Also Hunt's Merchants' Magazine. Vol. viii., p. 548.
† Richmond Newspapers.

they have so few ships to carry their iron to Great Britain, they must be content to make it only for their own use. The four furnaces, then at work in East Virginia, circulated a great sum of money, for provisions and all other necessaries, in the adjacent counties. They are, besides, a considerable advantage to Great Britain, because it lessens the quantity of foreign bar iron, heretofore imported there, and paid for in silver. On the contrary, all the iron they receive from the plantations, they pay for in their own manufactures, and send for it in their own shipping."

Colonel Spotswood also erected an air-furnace at Massaponux, which he brought to perfection, and was able to furnish the whole country with all sorts of cast-iron, as cheap and as good as ever came from England."*

In 1750, a bill was passed in parliament for the repeal of the duties on the pig and bar iron made in the British colonies of America; but the interest of the iron manufacturers in Great Britain prevailed so far, as to add to the bill a clause, prohibiting the erection of any mill or other engine for slitting or rolling of iron, or any plating forge, to work with a tilt hammer, or any furnace for making steel; for it was feared that the colonies might interfere with the manufactures of their mother country.

In 1775, the American war with England broke out, and, at its termination, a new era commenced in the history of the American iron trade.†

* Westover Manuscripts. 1841.
† Scrivenor's History of the Iron Trade.

VIRGINIA.

LIGNITES IN SANDSTONE NEAR FREDERICKSBURG, OF THE OOLITE AGE.

In 1834, the Geological Society of Pennsylvania, published in their first volume a paper, communicated by the author of this work, on the Lignites of the secondary horizontal strata of Fredericksburg, accompanied by six lithographed figures of plants. These lignites are in no place in sufficient abundance to constitute a seam or bed, much less a workable bed; but as interesting specimens of silicified masses of wood, and fragments even of large trees, which reminded us of those of the Portland rock of the South of England; besides an infinite number of impressions and carbonised remains of more delicate varieties of plants, that are not undeserving of a passing notice.

On looking over the imperfectly defined series of these plants, it will be seen that they are all cryptogamous, cellulares, or acotyledones, with the exception of Thuytes; and that they belong to genera some of whose species are distributed abundantly amongst the coal vegetation of all parts of the world. These species, however, appear to be new; that is, they do not belong to the carboniferous period. One approaches to the oolite period, and the consideration given to this group of plants led to the conclusion that they were "perhaps coeval with the oolites."

The large broken masses of silicified wood are, unquestionably, remains of vasculares, or dicotyledonous plants or trees, no member of which, we believe, has yet been observed in our ancient coal vegetation. These resemble, somewhat, the silicified wood of the Portland oolite; and, like them, exhibit no marks of perforation by the teredo.

It must be observed, that all the genera to which we have assigned the fossil plants of Fredericksburg, occur in the oolitic group of Europe. For this fact we have the testimony of M. A. Brongniart; of Saussure, Phillips, Murchison, De la Beche, and many others. Mr. Nuttall has described silicified wood, near the James River, having characters resembling those we have mentioned at Fredericksburg.*

If we mistake not, Professor W. B. Rogers has also satisfied himself that the date of the Fredericksburg sandstone "is referable to that of the oolite."†

The geological and topographical position of this lignite sandstone is immediately beneath the older tertiary formation, and superficially occupies a belt immediately west of it, overlying the primary rocks of Fredericksburg and Petersburg.‡

Between Fredericksburg and Richmond, lignite and thin seams of impure bituminous coal, according to the State Surveyor, are of frequent occurrence

* Trans. Geol. Soc. of Penna. 1831.
† Proceedings Acad. Nat. Sciences, Philad. Jan. 1842.
‡ See also—The Virginia Annual State Report, 1840, p. 27 and 35. American Journal of Science, vol. xxix. p. 86.

in these feldspathic sandstone beds, provisionally termed "upper secondary sandstone," which are, in many places, largely intermingled with dark coloured micaceous slates and bituminous shales.

PETROLEUM.

In the valley of the Little Kanawha, about six miles from the mouth of Hew's River, is a spring from which from fifty to a hundred barrels of petroleum are annually collected. Petroleum also rises in nearly all the wells in the salt region of the Kanawha.

V. KENTUCKY DIVISION

OF THE GREAT ALLEGHANY COAL-FIELD.

The superficial coal area within this State we have computed at 9,000 square miles.

Professor Mather computed it at only seven thousand, which if we estimate the workable or productive area of coal alone, would be very ample. In 1837, an address, recommendatory of a State geological survey, was made by Mr. Trimble to the Kentucky legislature.* In consequence of this movement, Professor Mather was instructed to make a geological reconnoissance of the state, which was accomplished the following year, 1838. Since that time, no further progress towards a more detailed survey has been made, and our information is less ample than could be desired.

The congressional return from Kentucky, in 1841, shows that she raised in 1840, 588,167 bushels, or 21,000 tons of coal, an amount far below the actual production.

There appear to be several qualities of coal here. The "main seam," which extends from Pittsburg and Wheeling through Virginia, is said to reach Sandy river at the boundary of this state, but does not pass into it, or extend but a very short distance, southward.

Of Cannel coal, several seams are said to be found on the Kentucky river, and the quality is highly commended.

Nearly all the coal brought into use in Kentucky is reported to be of the description called *Cannel.* It is slightly bituminous, but rarely cakes in burning. Its analysis seems to ally it to the dry or semi-bituminous coal of the Cumberland mountain, described by Dr. Troost.

Mr. Trimble details some experiments made by steam-boats on the Ohio, from which it was ascertained that the daily expense of fuel, when mineral coal was used, was less than one half that of cord-wood.

Four hundred and fifty steamboats, using twenty cords of wood in the twenty-four hours, and running two hundred days per annum, will consume an amount of wood, whose value at $2 50 per cord, would be .	$4,500,000
By the use of coal, during the same time, and producing similar effect	1,500,000
Annual saving	$3,000,000

The price of this coal at Louisville, in 1844, was seven and a half cents per bushel, by the boat load, equivalent to two dollars and ten cents per ton.

Mr. Mather's report (1838) to which we shall now more particularly advert, states that, at that time, at least one million of bushels [35,714 tons] were annually sent to market from the mines on the principal rivers.

He estimates that the coal formations of Kentucky cover twelve thousand square miles, of which seven thousand square miles contain workable coal beds.

* Hon. D. Trimble; Report on the coal and iron trade of Kentucky, 1837.

The coal is of three varieties—

1. Bituminous—Caking coal.
2. do. but not adhesive.
3. Cannel, or Splint coal—Steam coal.

Besides the million bushels which descend the principal rivers, about two millions more are consumed in the iron and salt-works of the State; thus amounting to 107,143 tons. This shows the fallacy, we have before pointed out, of the census returns, which, two or three years afterwards, when the production was greater, only included 21,000 tons.

The use of coal for steamboats, the reporter urges, is increasing rapidly, and its recommendations, for that purpose, are principally these—

1. It makes a more uniform and more easily regulated fire than wood.
2. The economy in the use of coal, over wood, is three-fifths.
3. The weight of equivalent quantities of coal and wood is as one to three.
4. The bulk do. do. as one to nine.
5. The labour and expense do. putting on board, as one to four.*

The geologist enumerates a great many details and localities within the Kentucky region where coal prevails.

The *Cannel coal*, on the bank of the Kentucky river, occupies a bed of four feet thick, of which about three feet are of this variety, the remainder, or upper part, being common bituminous coal.

The bituminous coal seams of Kentucky appear seldom to exceed three feet thick, and in general are of less dimensions. They are, however, accompanied, throughout the entire extent of the coal field, by the valuable mineral, argillaceous carbonate of iron. Mr. Mather's calculation is that it averages one yard thick over the whole 12000 square miles; equivalent to 38,400 millions of tons: "a quantity sufficient to supply a ton of iron, annually, to every individual in the United States, [the population being then fifteen millions,] for 2,560 years." But we have stated that not more than 7000 to 9000 square miles contain workable coal beds. If such an amount of iron ore really exists as three feet in thickness, under the entire area of the coal-field, it far exceeds any thing of the kind in any other region we are familiar with in the United States; for rich as the States are in this mineral, in the aggregate, the supply from the carboniferous strata, appears to be but feeble and uncertain; although the deficiency seems amply compensated for in the immense supply of hematite furnished by the subjacent limestone series.

* Robert Triplett's Circular.

VI. OHIO DIVISION

OF THE GREAT ALLEGHANY COAL-FIELD.

The superficial coal area within this State we have computed at 11,900 square miles.

At what period the principal deposits of mineral coal became known is uncertain. On the ratification of the treaty of peace in 1763, Colonel Croghan was the first agent deputed by the British government to descend and explore the Ohio, and conciliate the Indian occupiers. His private journal, which was only published in 1831, makes no allusion to coal in this state, but he especially noted the beds of coal on the banks of the Wabash.* It was certainly known shortly afterwards; for in Captain Hutchins' map, published in London in 1777, we observe that coal mines are marked on the western side of the Ohio river.

Occasional notices of portions of the Ohio coal region, and certain local developments therein, have long ago appeared.

In 1835, an elaborate article was published in Silliman's Journal of Science, "on the bituminous coal deposits of the valley of the Ohio," by Dr. S. P. Hildreth. It furnished some useful details of coal operations and statistics, in this and the bordering States. This memoir was illustrated by a great many wood cuts of fossil remains, local sections, and a geological map of the Ohio valley, including parts of Pennsylvania, Virginia, and Ohio. The geological investigations set on foot in those States, by direction of their local governments, have, in great measure, already superseded Dr. Hildreth's memoir. Nevertheless, as the work of an individual explorer, unassisted by the official patronage and the treasuries of those States, it is deserving of honorable mention, as a serviceable contribution to American geology.

It has been, not unfrequently, observed, in relation to the State surveys, that they have more regard to technical and theoretical geology, than to practical and industrial results. In this light, it has been argued, these State surveys have somewhat failed in the utilitarian results expected from them. Perhaps it were scarcely fair to unite all these multifarious duties in the same party. Geologists are commonly occupied with duties sufficiently onerous and laborious in their specific departments, and in investigations over fields heretofore little trodden by men of science, to make much progress in economic and statistical researches. It were better, no doubt, that these distinct subjects of inquiry were divided, or that they should follow each other. On the whole, we think we are not far wrong, in the belief, that the American geological surveys do, in point of fact, contain more details of statistical, commercial and industrial utility, than can be found in the geological reconnoissances and memoirs of any other country.

* Monthly Journal of Geology. Vol. I.

But to return to that of Ohio. The attention of the legislature having been called to the subject by the governor, a select committee reported on so much of his Excellency's message as related to a geological survey of the State.

Professor W. W. Mather, in association with Dr. J. Locke, and other competent assistants, commenced the survey, and one report of their joint labours appeared in 1837, and another in 1838. As the reports of the former gentleman are always characterised by special attention to economic geology, those of Ohio furnish a large amount of important statistics, from which many of the following notes are derived.

From the magnitude of this coal field, which comprises one third of the entire area of the State—bordered by the Ohio river for three hundred miles, and intersected, longitudinally and centrally, by the Ohio and Erie Canal—it will readily be perceived that its coal mines must be classed with the most prolific sources of local productive industry.

In the words of the reporter, "it is estimated that about twelve thousand square miles are undoubtedly underlain by coal, and five thousand by *workable beds* of that valuable mineral." This estimate appears to be a very fair one, and precludes all misapprehension as to the available amount.

The physical features of the country are favourable to the working of these horizontal coal strata, by the simple means of adit levels; and it will be long ere the wants of the community call for another system of working, either by steam power, deep shafts, or costly machinery.

"Probably a mean thickness of six feet of coal, capable of being worked, over five thousand square miles, is a moderate estimate of our resources in this combustible."* According to certain data, there are now beneath the surface of these five thousand square miles, thirty thousand millions of tons of coal. In the ordinary method of computation, in these cases, we may safely estimate that at least twenty-three thousand millions of tons are available. Could we contemplate a demand for Ohio coal as large as five millions of tons per annum, there will be an annual supply unexhausted until the termination of four thousand six hundred years.

In the seond annual report, the author, after revising the geological data which form the basis of this computation, affirms, that from the information subsequently acquired, in 1838, he felt not only justified in sustaining the foregoing statement, but in materially enlarging it, for it had been proved by later investigations, that, in some counties, the coal was from twenty to thirty feet thick, in the aggregate.†

In the official report to Congress, in 1841, it appears that there were raised within the State in 1840, 125,478 tons of bituminous coal; employing four hundred and thirty-eight workmen, and $46,775 of capital.

In 1838, the quantity produced was estimated at 107,100 tons.

The Ohio geologist urged the substitution of mineral coal for the ordinary charcoal, in iron works. It had already been partially adopted by means of a mixture of the two kinds of fuel. The Ohio coal is proved to make excellent coke; and in that state is used in equal proportions with the charcoal. In effective result, it is ascertained, that an increased make of iron occurs; equal, it is affirmed, to thirty-three per cent.

The price of coal here, as elsewhere, fluctuates according to the demand. It is considered to be worth four cents per bushel at the place of production;

* First Annual Report, by W .W. Mather, p. 5, 6. 1837.
† Second Report, 1838, p. 7.

and after being conveyed one hundred miles, to the ports of Cleveland and Erie, it usually sells for fourteen to sixteen cents per bushel; and, at more distant points, it produces eighteen cents per bushel; equivalent to from three to five dollars per ton, at the places of consumption, according to the distance of transportation; even reaching as high as ten or twelve dollars a ton at New Orleans.

The ordinary charcoal furnaces in Ohio require a command or resource of from two thousand to five thousand acres of wood land, to keep them constantly supplied. Now, with six feet of coal beneath the very ground upon which the furnace is erected, the produce of only half an acre, annually, would be needed, while its surface would still grow timber, or be under cultivation. Such are the different circumstances which attend the two descriptions of fuel.

Like all districts which are covered with primeval forests, Ohio will long continue to make use of wood for domestic use, until it be exhausted, or shall become more expensive to procure than coal.

One hundred and four thousand three hundred and twelve tons of fuel were consumed in the iron works of Ohio, in 1840.

Raw bituminous coal has at length [1846] been solely employed in a blast furnace in this State, at Poland, on the Mahoning river. This is the first American furnace in which pig iron has been so made.

At Carr's Run, one hundred and sixty miles below Wheeling, and two hundred and four miles above Cincinnati, an important seam of coal is mined, and this fuel is supplied to the steamers as they pass along the Ohio river. It is dug almost at the water's edge; and, consequently, the cost of transportation is a mere trifle. The price of the coal is generally six cents a bushel. In regard to quality, this is a lighter and drier coal than that of Wheeling; being less bituminous and less adapted to the uses of the blacksmith; but it is better approved for steam-boats and for reverberatory furnaces. The same vein is worked on the Kentucky, or opposite side of the river.

CAPACITY.

Professor Briggs divides the Ohio coal district into two geological series; the higher and the lower group.* The lower series embraces but a portion of the main area towards the east, in Jackson, Scioto, and Lawrence counties. In these he has observed three workable beds of coal. "The aggregate thickness may be safely estimated at from ten to twelve feet." The gross quantity of the coal beneath this area, which is represented to be two hundred and fifty square miles, is computed to be two thousand two hundred and fifty millions of tons; which, upon the ordinary method of computation, and presuming that it is accessible to the miner, may be reckoned about seventeen hundred millions of tons, of available coal. It would be more prudent, however, not to extend the estimate beyond fifteen hundred millions. It is but right to add here, that a more detailed examination, subsequently, led the reporter to enlarge his computation to three thousand millions of tons.†

In the Ohio second annual report, is an account of the coal of Muskingum County, through which the river of that name passes. Here are six workable beds; four of which extend nearly thirty miles through the county, and

* Briggs' First Report, as Assistant Geologist. 1837.
† Briggs in Second Report of Ohio, p. 141. 1838.

two extend about fifteen miles. The aggregate thickness of available coal being determined to be eighteen feet, the amount of fuel is hence computed at three hundred and fifty-nine millions of tons. Admitting a profit of only twenty-five cents per ton, the result on this comparatively small fraction of the gross productive coal area, is found to be about ninety millions of dollars—$90,000,000.

The Tuscarawas valley and adjacent district, lying north of the preceding, comprehend, according to the authority last quoted, an area of about five hundred and fifty square miles; which on a rough calculation, is considered to be underlaid by an average thickness of six feet of coal. These data, therefore, furnish a gross result of thirty-three hundred millions of tons, of which probably about two thousand millions are attainable.

STATE IMPROVEMENTS IN OHIO.

State Canals and Roads, eight hundred and fifty-two miles, cost $15,283,-783. Gross revenue derived from the six canals and other State works in Ohio.—In 1844, $569,676; in 1845, $494,313; in 1846, $630,770.

THE LAKE TRADE FROM CLEVELAND.

Since the opening of the canal, from the coal-field to Lake Erie, at the Port of Cleveland, the latter has become an important outlet for the productions of this State.

The following table comprises the collector's annual returns of mineral coal which arrived at Cleveland, *via* the Ohio Canal, and also the amount which was shipped at the port.

	Received by Canal.		Shipped.
Years.	Bushels.	Tons.	Tons.
1830		5,100	
1837		12,269	
1838		9,298	
1839	140,042	5,000	
1840	167,045	5,065	
1841	479,441	17,122	4,329
1842	466,844	16,673	2,825
1843	387,834	15,515	11,168
1844	550,842	22,035	16,613
1845	889,880	31,781	
1846	893,806	31,921	
1847	1,238,622	44,236	

LAKE COMMERCE OF CLEVELAND, OHIO.

Years.	Vessels.	Tonnage.	Men employed.	Exclusive of steamboats.		Steamboats.		Coal Exported.		Value of Exports.
				Arrivals.	Departures.	Arrivals.	Departures.	Tons.	Value. dolls.	
1830	15	1,029		213	218					
1835	38	3,962		878	870					
1840	66	9,304		1,344	1,344					
1842	80	8,671		1,418	1,412	1,050	1,050	2,825	7,119	$5,851,898
1843	86	9,386	565	1,382	1,432	1,100	1,100	11,168	35,204	
1844	98	11,738	681	1,472	1,522	1,260	1,260	16,613	49,839	
1846										$7,040,492

In 1841, out of 1364 arrivals at this port, 437 were from Canadian ports on Lake Erie, and from American and Canadian ports, *via* the Welland Canal.

Out of 1366 departures, 422 were to Canadian ports, and similar places as before named. In 1842, entered from Canada, 356; cleared for Canada, 363.

In 1846, the foreign [Canada] trade of this port was as follows:

ARRIVALS AND CLEARANCES.

In American vessels,	165 vessels,	12,258 tons.
In British vessels, .	162 "	18,759 "
	327 vessels,	31,017 tons.

Hence it would appear that the trade with Canada is diminishing at this port.

COMMERCE OF THE LAKES ABOVE NIAGARA FALLS.

As bearing collaterally on the progressive advancement in the indigenous production and commerce of the States which border upon the Upper Lakes, we add a few statistical notes.

General Commerce of the Upper Lakes, showing the periodical increase.

Years.	Observations.	Steamers and Propellers.	Shipping of all kinds.	Tonnage	Steamboat Receipts.
1825	Tonnage on the Lakes, - - - -	1		2,500	
1832	First year after opening the Ohio Canal,			8,552	
1833	Second year,* - - - - -	11		10,471	$229,212
1836	Fifth year, - - - - -			24,047	
1838	Seventh year, - - - - -	15	73	34,277	
1840	Ninth year, - - - - -	43			$725,523
1841	Tenth year, - - - - -			41,184	767,123
	On all the lakes, - - - - -			56,252	
1845	Fourteenth year,† - - - -	60	380	76,000	
1846	Tonnage at the end of the 15th year,	80	452	91,250	
	" on all the lakes, -			106,836	
1847	In commission, on the western lakes,	86		113,000	

There are now steamers on the Western Lakes, of 1140, 1300 and 1705 tons burthen.

PORT OF BUFFALO ON LAKE ERIE.

Number of arrivals from the lakes in 1825, only 200 of all descriptions; in 1846, steamers, 1310, propellers, 200; other vessels, of various denominations, 2,357. Total arrivals, 3857; aggregate tonnage, 912,957 tons.

Value of the property arrived and cleared on the canal at Buffalo, in 1846, $38,214,025.

Coal received at Buffalo from the lake, chiefly from Pennsylvania,

995 tons in	1845				*Tons.*
4330 "	1846	Arrivals from Canada,	487	vessels,	95,879
7716 "	1847	Cleared to Canada,	492	"	96,441

* Letter on the Lake Commerce, by J. L. Barton. Buffalo, 1846.
† Buffalo Commercial paper, Sept. 9, 1847.

PORT OF ERIE.

Export of Bituminous Coal received from Pennsylvania.

Years.	*Tons.*	*Value.*
1845	8507 =	$21,218
1846	21,534 =	53,835

Total receipt of coal at the Port of Erie, by the Erie Extension Canal,

1846	25,000 tons.
1847	70,000 "

Number and description of vessels built on Lake Erie, during six years, from 1841 to 1846, inclusive: Steamers, 47; propellers, 19; sailing vessels, 185. Total, 251 vessels, having a tonnage of 49,801 tons.*

NEW YORK STATE.

Statement of tolls received at three of the principal lake ports of New York, viz. Buffalo, Black Rock, and Oswego, in the years 1845 and 1846, showing an advance of 50 per cent.

1845	$677,922
1846	1,013,478

MICHIGAN.

Value of exports from Detroit, Monroe, St. Josephs, &c.

			Tons.	*Seamen.*
In 1840	$1,305,860			
1846	$4,647,608	Tonnage enrolled,	26,928	1800

DETROIT.*

Value of exports in	1842	$1,108,000
" "	1844	1,747,000
" "	1846	2,495,333

TOTAL COMMERCE OF THE LAKES.—CLOSE OF 1847.

By a report furnished by the Topographical Corps, through the Secretary of the Treasury, at the close of the year 1847, we have an official account of the Lake Commerce in 1846, of which the following is a summary:

Nett value of the *bona fide* trade for 1846—being nearly double the amount in 1841,	$61,914,910
Amount of registered, enrolled and licensed tonnage on the lakes for 1846—being nearly double the amount in 1841,	*tons* 106,836
Number of clearances and entries,	*Number* 15,855
Goods exported and imported; the whole American lake tonnage, in 1846,	*Tons,* 3,681,688
Goods exported and imported in 1841,	$2,071,892
Number of passengers conveyed, in 1846, not less than	250,000
Amount of passage money paid,	$1,250,000
Number of mariners employed,	6,972
Cost of shipping, in 1846,	$5,341,800

* Hunt's Merchants' Magazine, March 1837, p. 322.

Population dependent upon the Lakes as the means of communicating with a market, - - - - - - -		2,928,925
Steam tonnage of the lakes, - - - - -	60,825	
Sailing tonnage - - - - - - - -	46,011	*Ts.* 136,836
British shipping employed in the American lake trade,	30,000	
Receipts in 1846, - - - - - - - -		$13,184,910

WESTERN RIVERS.

From the same official source, we add the amount of the steamboat navigation of the Mississippi and its tributaries, - - - - - - - - -	*Miles,*	16,674
Steamboat tonnage on the Western Rivers in 1842, -	*Tons,*	126.278
" " " " in 1846, -	"	249,055
4000 boats of other kinds, of 75 tons average each,	"	300,000
Tonnage of flat boats, making two trips a year -	"	600,000
Merchandize transported, 1,862,750 tons, of the value of		$61,914,910

VII. MARYLAND DIVISION

OF THE GREAT ALLEGHANY COAL-FIELD.

The superficial coal area within this State we have computed at 550 square miles.

The topographical details of the published maps differ so much, that it is quite impracticable to be precise in estimating the areas and subdivisions of the Maryland coal region. The external boundary of the entire field is sufficiently defined: we are not so certain of the interposing areas of the subordinate rocks, which divide the district into at least three portions. The geologist of the state appears to have experienced the inconveniences consequent on so imperfect a topographical survey. In page 48, Report of 1836, the Frostburg coal area is stated to be 180 miles square. In the final annual Report, of 1840, page 18, the area is given at 90 miles, and by another statement 135 miles. Our own admeasurement is 150 miles. These discrepancies arise, evidently, from the uncertainty of the point adopted as the southern termination of the district in question. Taking the Frostburg region at 180; (the largest admeasurement,) the middle area between Negro and Meadow mountains, at 120; and the northwest or Youghagany field, at 250, the aggregate of bituminous coal land in the State of Maryland is 550 square miles. We make this statement with some hesitation; but we conceive the entire amount will not exceed, and will possibly fall short of what we have computed.

As before stated, we assigned 150 square miles for the productive area of the Cumberland or Frostburg coal-field. By reason of the basin-shaped conformation of its stratification, and by the uprising of the subordinate old red sandstone formation to the surface, this eastern area is separated from that to the westward by a belt, a few miles broad. The second coal area, situated beyond the great backbone ridge of the Alleghany mountain, has an uncertain southern termination; being separated by another denuded belt of red sandstone, from the third coal-field, which thus fills up the remaining part of the northwest angle of Maryland.

Although the aggregate, 550 square miles, appears small when compared with some of the vast areas appertaining to other States, yet, in productive value, and in advantages of locality, we conceive that it is greatly superior to the bulk of the coal land which is situated beyond the State line, on the west, and intermediate between that boundary and the Ohio slope. As an accession to the resources of Maryland,—for the substitution of what was regarded, a quarter of a century ago, as almost a worthless appendage to the State, for that which now promises to be the most productive, may justly be deemed an accession,—it cannot fail to be appreciated for its almost immeasurable importance. After long years of expenditure, in constructing canals and railroads, to communicate between these abundant coal deposits of the mountains and the seaboard, this enterprising State has but now seen the

partial completion of her principal works; and it only remains for her to reap the reward to which the perseverance of her citizens entitles her.

From amongst the various reports, public and private, of the Maryland coal region, or more properly speaking, of the Frostburg or Cumberland portion of it—for of the back country we know very little indeed; we cannot positively determine the number of workable coal beds; even in the best explored portion of the latter district.

There are, according to Dr. Ducatel, at George's Creek Valley, four workable coal seams, which have an aggregate thickness of thirty feet.* South of this, at Westernport, two veins are mentioned, comprising eight feet: and beyond these are four or five others, imperfectly known, but probably are continuations of the preceding, or of a part of them. At "Dug Hill," another position in George's Creek Valley, the reporter enumerates ten coal seams, which average four feet each, or forty feet in the aggregate. We are not informed how far these may be repetitions of those before mentioned.†

A published report of the George's Creek Coal and Iron Company contains a section of the excavations which have been made at this "Dug Hill," which we infer is the place, on which, more recently, has been conferred the name of Lonaconing. There are shown here ten coal beds, of which four only are workable, and of which the aggregate thickness is thirty feet. That of the six others is only ten feet.‡ The corrected Lonaconing section, plate iii. of the State Geologist's Report of 1840, exhibits six workable seams, which have an aggregate thickness of thirty-five feet; the other four seams amount only to six feet. Below this, thirty-five feet series, viz. from Lonaconing, down to Westernport, twenty-five feet of coal are known, but are chiefly made up of small seams, of which about fifteen feet are workable. By these data we make out fifty feet, as the maximum workable coal of the Frostburg region: but according to Dr. Ducatel, not more than forty-five feet can be calculated upon.

In another part of the basin, at the works of the Maryland Company, in one position, the explorations have developed three seams of coal, amounting to twelve feet thickness. At Mount Savage are six other seams, forming in their aggregate twenty-six feet of workable coal. These form part of the general group.§

At a place called Barrellville, in the Cumberland district, eight veins occur, whose average is three feet, six inches each, in thickness.

Portions of the areas of the lower beds are destroyed by the erosion of the valleys. For instance, George's Creek, according to Dr. Ducatel, "has scooped out its bed through twelve hundred and fifty feet of perpendicular elevation; while Jenning's Run, he observes, has, in the short distance of six miles, cut, both longitudinally and transversely, even into the subjacent red sandstone." The lateral ravines have also subtracted largely from the area of the lower beds. It was the knowledge of these extensive denudations and removals, especially in the most mountainous portions of the coal-fields, and in those districts where the coal formation undulates, that gave rise to our previous remarks on the necessity of making large allowances for barren or inaccessible ground, when calculating coal areas. We could

* State Geological Report, in 1836, p. 50—54. The assays of these coals will be found at the conclusion of this book.

† Annual State Report for 1840, p. 28—33, and plates i. ii. and iii.

‡ George's Creek Coal and Iron Company's Report, 1836, p. 11, Map and Sections.

§ Report, in 1844, by Messrs. Silliman and others.

point out considerable districts, towards the northern termination of this Alleghany coal-field, where, certainly, not one acre in ten, and often not one acre in a thousand, contains a bed of coal in a workable condition, or even a single ton of that mineral.

In the northwest angle of Maryland, part of the coal measures are cut out by the Youghagany river; also by two parallel zones of the inferior red sandstone, along Deep Creek; and there is an extensive sweeping away of strata along the Potomac valley, which is a trough at least fifteen hundred feet in depth. When due deductions are made for these interruptions to the continuity of the coal formation, our estimate of five hundred and fifty square miles will be found a very liberal one.*

This principle has been fairly observed in the last State Report, when applied to the Frostburg or eastern coal-field. By attending to a rule so obvious and so indispensable, the geologist is compelled to reduce the area of actual coal bearing surface to 135 square miles, or 86,847 acres.

According to the foregoing data, the result gives, as the gross amount of coal in the entire basin, supposing the whole to be accessible, 6,305,137,287 tons, and the available quantity, on the ordinary mode of calculation, will be upwards of four thousand millions of tons.†

The price of Cumberland coal, delivered at Tidewater, Georgetown, was, in 1838, about 20 cents per bushel; a higher price than is usually obtained in Philadelphia. The cost of mining was $1 per ton, and of transportation, by canal, to tide supposed to be $2.85 per ton: to which must be added the respective profits of the land owner, the producer, and the merchant. This estimate was thought, at the time, to be considerably below the mark.‡ The representations and reports of interested parties, all strenuously advocating their individual or local claims on the attention of Congress and the public must, of course, be received with a requisite degree of caution. At this distance of time, we shall, doubtless, be pardoned this remark, while necessarily reviewing the statistical merits and details of the entire coal resources of the country. We continually meet with the unreserved and unqualified assertions of these claimants, that the coal of their particular mine or district, no matter where, is the best yet discovered, for every practical use. Now, as they cannot all be the best, it follows that a good deal of exaggeration prevails, in some of these cases. It is not inappropriate to state here, that there are probably a dozen or more of coal companies, in England, Wales, and America, who announce through the press, that their particular coal has been decided by the agent of the Great Western Steamship Company or some other steamer company, to be the best generator of steam of all coals yet tried. One gentleman has also conclusively shown, that one ton of the bituminous coal of Cumberland, Va., is, in mechanical effect, equal to two tons of anthracite.

However, the test of science restores all things to be their true value.

* Vide the map and profiles appended to the State Report, for 1840.

† We may form some estimate, from this computation of available coal within an area so small as scarcely to be noted upon our map, of the enormous quantity in the aggregate of the American coal-fields. There needs no fear about exhaustion, at least not before the termination of a great many thousand years, according to the present rate of consumption. In regard to the Old World, also, the progress towards exhausting the numerous coal-fields is comparatively insignificant. We have computed, from five coal-fields in Great Britain, a production of 116,000,000,000 tons, or more than 5500 years supply for consumption and exportation, on the present scale. The Lancashire coal-field will yield 8400 millions; the Mid Lothian district 5710 millions; the Newcastle 9000 millions; the South Wales basin 64,000 millions of tons, available.

‡ Communications to the Committee of Congress on a national foundry, pp. 71, 147, 157.

The examinations of Prof. Johnson, in 1844, have dispelled many illusions; and have assigned to all the principal varieties of American coals their appropriate place in the catalogue: and here, the Cumberland coal takes the very highest place, in the series, in the order of evaporative power.

The analyses of the Cumberland or Frostburg coals show that the quality is, generally, of the kind denominated dry or close burning; an intermediate species between the fat, bituminous, caking coals, like those of Pittsburg, for instance, and the non-bituminous varieties, like the Pennsylvania anthracites. The largest, or ten feet seam at Lonaconing contains twenty per cent. of volatile matter, and there are some beds which do not possess more than from thirteen to fifteen per cent. of volatile matter, including moisture. The carbon in these coals amounts to from sixty-eight to eighty-one per cent., which circumstance accounts for the deservedly high reputation, as generators of steam, that they have enjoyed.

Were it needed in the process of iron manufacture, there is no difficulty in making good coke, from the majority of the Cumberland coal seams. All these varieties have undergone a chemical examination by scientific experimenters. Professors Silliman, Shepard, and others have shown that the main or ten feet Frostburg seam, which, having been the longest worked, has conferred a character on the Cumberland coal, contains but 13.34 per cent. of bitumen, besides 1.66 of water. Such an amount as 82 per cent. of carbon which these analyses show it to possess, while at the same time it retains enough of the properties of a flaming coal, carries its own best commendation, and places it very high, if not the very highest, in the scale of American coals; a reputation which is fully sustained by the subsequent investigations of Prof. Johnson. It closely resembles some of the Stony Creek semi-bituminous coals of Pennsylvania, in all the essential particulars; except that the latter does not swell nor cement so much in burning.

A special report of the president of the Chesapeake and Ohio Canal Company furnishes the details of an experiment at sea, 22d October, 1839, made on board of the U. S. steamer Fulton.

The object was to test the Cumberland semi-bituminous coal, against a highly bituminous Liverpool coal.

The chemical characters of each of these kinds might have at once suggested the exact results obtained. The Cumberland coal having more carbon, would acquire a more intense and concentrated heat; and, as it possessed less bitumen, would give out less smoke than the fat coal.

The former, from the same reason, would have its fragments less changed and cemented; while the latter would be caked or agglutinated in a mass, like all caking coals. The Cumberland coal made most clinker; the Liverpool coal possessed most sulphur.*

With a knowledge of the chemical composition of various qualities of coal, it is superfluous, at the present day, to institute a series of experiments like this, between anthracite and bituminous coal, or their modified varieties, now perfectly well understood. That any fuel of the specific nature of the Frostburg coal, can readily produce all the comparative results afforded by the experiment, there cannot be the slightest doubt.

The application of bituminous coal to the purposes of iron making after the method of the English works, has proved so successful, that between the years 1840 and 1844, five blast furnaces and two rolling mills were

* Special Report of the Pres. Ches. and Ohio Canal Co., 1839, p. 38, 39.

erected in Maryland and Pennsylvania, upon this principle, instead of the old charcoal furnaces.*

Some of the coal of this region, within four miles of the town of Cumberland, was submitted to the examination of the late David Mushet a few years ago. He remarked that "it was the very best bituminous coal he had ever met with," and considered it well adapted to iron making. Three specimens of the varieties of iron ore of this region were, at the same time, reported upon by Mr. Mushet. The results of his analysis were as follows:

Brown fibrous hematite, of excellent quality, yielded of best cast iron, - - - - - - -	62.6
Common argillaceous iron stone of the coal measures, yielded,	34.3
A very fine argillaceous iron stone, yielded of best cast iron, -	41.4

These were probably selected specimens, and are above the average result.

PRODUCTIVE CAPACITY.

In the report of the Baltimore convention, December, 1834, is introduced an extract of a report of Mr. Roberts, to the directors of the Baltimore and Ohio Canal Company, to the following effect:

"As each square mile of the great vein alone—thirteen feet thick—would yield more than sixty millions of tons, if it could be exported at the rate of five hundred tons per day, it would require four hundred years to exhaust one square mile of the great coal vein!"†

There is surely a great miscalculation here. In the first place, the seam of coal contains little more than twelve, instead of sixty solid millions of tons per square mile, at the thickness named; and, according to the usual allowance in these estimates, would not yield more than from eight to ten millions of tons. Messrs. Silliman, in a subsequent report of the same locality, in 1838, state that this main or ten feet coal seam can only be worked nine feet or three yards.‡ This gives, for the solid cubical quantity in the ground, nine millions of tons per square mile. Making the customary allowance of one fourth for waste, for pillars, broken ground, casualties, &c., the available amount is 6,750,000 tons, instead of sixty millions. At five hundred tons mined per day, it would, therefore, with these data, require little more than forty, instead of four hundred years, to exhaust one square mile.

Even on this corrected scale, the resources of this region are demonstrated to be of very productive character; surpassed, probably, by none on the eastern margin of the Alleghany mountain range.

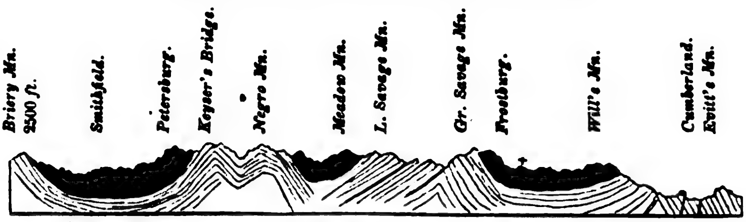
The statistical returns of 1840 show the production of bituminous coal in Maryland, to be 222,000 bushels: equivalent to 7,928 tons. At that time the means of transportation were very limited, and access to the mines was difficult.

But the quantity is obviously under-rated. As early as 1832, 300,000 bushels were annually sent down the Potomac river. Very little of this descended lower than Harper's ferry, but the quantity increased every year.

* Letter of the Committee of the Iron and Coal Trades of Pennsylvania, April, 1844.
† Report of the Baltimore Convention, 1834, p. 49.
‡ Report of the Maryland Mining Company, by Messrs. Silliman, 1838, p. 15.

Fig. 3.

Geological Profile of the Coal Basins of Maryland.



Constructed from Dr. Ducatel's larger section.

As relates to the two other coal areas which lie in this state to the west of the Alleghany ridge, and of which we have been able to say so little, we possess little or no information. Situated as they are, in the midst of a wild forest region, the mere existence of bodies of coal is inferred rather than proved, and they will, in all probability, remain undisturbed for many years.

COST OF TRANSPORTATION, TOLL, ETC.

These, being matters of annual revision, it would be useless to occupy space in detailing.

In 1846, the toll on the Chesapeake and Ohio canal, viz. from the Cumberland depot to Georgetown, or tidewater, was fixed at half a cent. per ton, per mile.

On the Baltimore and Ohio railroad, the rates of transportation, for the same year, were as follows:

The Cumberland road, 2 cents per ton, per mile.
To Baltimore, 1846, \$3.00 per ton, and \$2.50, in 1847.
To Washington city, \$3.56 per ton.

By a report in 1847, it is announced that the Chesapeake and Ohio canal will be opened to Cumberland, in 1849, and it was estimated the coal of the Frostburg district will be delivered at the low rate of \$2.50 to \$3.00 per ton, at tidewater.

The current price of coal in Baltimore, in 1848, \$6.00 to \$6.25 per ton.

MARYLAND.

LIGNITE.

In the Geological Report of Ann Arundel county, lignites or fossil mineralized wood, are stated to occur in great abundance. The ashes, which are derived from the spontaneous combustion of this lignite, form the principal material employed in the manufacture of alum and copperas, at the Baltimore works, on Locust Point.*

On the western shore of the Chesapeake Bay, on the banks of the Magothy, there occurs a considerable deposit of lignites, apparently in the upper secondary or green sand formation. These lignites are associated with iron pyrites and amber, the latter of which contains nests of insects converted into amber, and appears to have been formed around the smaller twigs of the wood from which the lignites have been produced.

Six miles below this locality, on the banks of the Severn, is another deposit of lignites and amber.†

* Report of Maryland, 1836, p. 30.
† Transactions of the Maryland Academy of Science and Literature, vol. i., part 1.

VIII. PENNSYLVANIA DIVISION

OF THE GREAT ALLEGHANY COAL-FIELD.

Estimated area 15,000 square miles, or 9,600,000 acres. Like most of the other states, Pennsylvania possesses no geological map. It is greatly to be regretted that the unfortunate pressure of the times and the imperious demand for the resources of the state for other objects, have made the postponement of the publication of the map, for which materials were collected during the geological survey, commencing in 1836, a matter of necessity.

In point of magnitude, this is the largest of the eight divisions of the Alleghany coal-field, with the exception of Virginia. As regards geographical position, it is, at the present day, more fortunately circumstanced than any other.

Some years ago, when geological investigation was in its infancy, a committee of the coal trade of Pennsylvania reported that the bituminous coal formation, within the state, covered 21,000 square miles.*

Our own computation is, that about 15,000 square miles are actually occupied by the carboniferous formation, or that which is usually denominated the coal measures. Various other statements have been made as to the size of this area. Among these is an announcement that "Pennsylvania contains more bituminous coal than all Europe. All Europe contains about 2000 square miles of bituminous coal: Pennsylvania has 10,000 square miles."† Here seems a remarkable misconception as to the area of coal in Europe; because, without passing on to the continent, the United Kingdom of Great Britain and Ireland alone contains more than 11,800 square miles of coal formations. In five out of fifty-one coal-fields within the latter area, eminent practical men have computed the available contents at 116,000 millions of tons. That of Pennsylvania, on the authority of the state geologist, contains 300,000 millions of tons.‡

For ourselves, we think that sufficient local details have not yet been acquired to enable a computation to be made of the available amount of coal within this extensive region. A superficial area of 15,000 square miles, to yield 300,000 millions of tons, would require an average thickness of twenty feet of accessible or workable coal, throughout every acre of that immense district. But, judging from the annual geological reports, there are very few points where twenty feet of coal could be worked at any one locality, and the average of aggregate thickness of such veins appears to be from ten to fifteen feet, viz: at the best exposed positions where sections

* Report on the Coal Trade, in 1834. Senate Journal, vol. ii., p. 488.

† Hunt's Merchant's Magazine, August, 1845, p. 138.

‡ Hazard's United States Register, vol. v., p. 99; Harrisburg Intelligencer; also, Mr. Biddle's Pottsville Address, 18th January, 1841; also, Mining Journal, of London, October 23, 1841. The previous paragraph is a specimen of the absence of correct statistical information, which has characterized the publications of the day, on the comparative magnitude of coal areas. More than one of those cited here contain the announcement that "Pennsylvania contains *ten thousand times* more bituminous coal than Great Britain and Ireland."

could be obtained,* it is well known that a very large area towards the northern extremity of the coal measures contains but a very small fractional portion of productive coal. We have seen statements that this field contains ten workable coal seams.† It is possible that within the entire series from the conglomerate upwards, ten such seams may exist—but we have not seen a position where more than half of that number could be approached, and seldom more than two or three are available at any given locality, except in the centres of the basins.

Until the publication of the final report, and until the sections, obtained with so much care during the geological survey, furnish the means of computing with greater accuracy than do the crude and isolated details at present within reach, it seems inexpedient to pursue this investigation any further.

We have extracted from the State Geological Annual Reports, the following notes as to the greatest number and thickness of seams of bituminous coal in the Pennsylvania Division, at any one workable or available spot.

Localities.	No. of workable beds.	Total thickness.
Philipsburg—Moshannon,	2	8 ft.
Near do.—Goss',	2	12
Clearfield Creek—Wright's,	3	8
Karthaus,	4	15
Bennett's Branch—Section,	3	10½
Toby's Creek,	3	7½
Little Toby's Creek,	2	8
Portage Railroad,	4	10½
Conemaugh River,	4	19½
Laurel Hill—Western Summit,	3	11
Lockport—Conemaugh River,	4	12
Rogers' Mill— Do.	1	6
Ligonier Valley,	4	17
South of the Youghiogheny,	3	—
Elk Lick—Main Section,	4	22
Cogenhouse—Lycoming county,	2	9
Lick Run, and Queen's Run,	2	8
Tangascutack,	2	6
Ralston—Lycoming county,	2	8
Blossburg—Tioga River,	1	3½
Alleghany River,	5	16
Conemaugh,	3	10½
Somerset county,	4	20
Frostburg—(Silliman,)	4	26
Average of 24 localities,		10½ feet.

GEOLOGICAL NOTICES.

At the period of the author's first acquaintance with the bituminous and anthracite coal-fields of Pennsylvania, nearly twenty years ago, he entered upon the investigation of American geology, imbued with the prevailing impression at that time generally advocated in Europe, and taught by nearly

* Rogers' Six Annual Reports of Pennsylvania.

† Geography of Pennsylvania, p. 122; Logan's Memoir on the Coal-fields of Pennsylvania and Nova Scotia; Proceedings Geological Society of London, vol. iii., part 2.

every geologist of eminence, that the anthracite deposits were of older origin than those of bituminous coal. In fact, the presence of anthracite was at one time thought to be conclusive evidence of a transition or grauwacké period, in contradistinction to the bituminous coal of the secondary formations.

The attendant circumstances of position, structure, mineralogical, and general characters, in the accompanying formations,—differences seemingly apparent even in several species of the coal vegetation,—all tended, at the outset, to confirm those suggestions, in a field which had previously received no scientific examination of moment.

By degrees, however, more correct views prevailed. Obscurities gradually cleared up; a host of intelligent observers almost simultaneously entered the field. At first, forming separate opinions derived from limited data or from a circumscribed range of observation, geological speculations were as numerous as were the observers. The pursuit was new to nearly all; the ground was almost untrodden. On entering upon so interesting a field, what more natural among ardent followers of the most fascinating of sciences than a variety of opinions? What more probable, at the commencement, than the advocacy of systems which more matured judgment abandoned as untenable?

As facts accumulated, and opinions were interchanged, difficulties vanished. The points of difference, at first so numerous, almost ceased to exist as new light came in. The energetic labours, applied at once over the greater part of the United States; the frank co-operation, during several successive years, of the various explorers, entitle them to all praise, and must ever render it a remarkable epoch, wherein was accomplished one of the most rapid and successful geological developments, that has occurred in the history of the science.

Let it not be inferred, however, that we consider the work as finished; it would be more proper to state that the general outlines only of American geology have now been satisfactorily traced, leaving for future observers to fill up the details.

Respecting the identity of the anthracite and the bituminous coal-fields of Pennsylvania, it is right to state that this view was entertained and advocated by Mr. Featherstonhaugh, in a course of geological lectures, delivered in Philadelphia, in 1831, illustrated by diagrams. It was then maintained that "the anthracite basin of the Wyoming valley exactly resembles the regular coal basins of Europe, of the bituminous kind."* The present writer, at that time, held an opposite opinion, as did other geologists; among whom a professor of high eminence, writing in 1833, remarked,—"We have in the United States three deposits of anthracite: the largest is in Pennsylvania; the next largest in Rhode Island; and the smallest in Worcester. I have examined them all, and have come to the conclusion, that all the rocks containing this coal are at least as low down, in the series, as the transition class; and I am rather of opinion that they all lie below the independent coal formation of Europe."†

Something like this view seems to have been held by Mr. Eaton, in 1830; for he stated the anthracite regions of Lehigh and Carbondale belonged to his "Third Carboniferous or Lower Secondary formation," while the bitu-

* Report of Mr. Featherstonhaugh's tenth Geological Lecture, in the United States Gazette, May 8th, 1831.

† Report on the Geology of Massachusetts, by Edw. Hitchcock, 1833.

minous district of Bradford, Tioga, and Lycoming counties, comprised his "Fourth Carboniferous or Upper Secondary."*

Even as late as 1837, in the geological report of Indiana, we meet with this passage:—"It is not likely that anthracite coal will ever be found in Indiana; because that mineral is usually found in the primitive and grauwacké formations."†

By this time, however, the doctrine of the supposed antiquity of the Pennsylvania anthracites had been abandoned, by common consent. It seemed no longer debatable in the United States. The reconnoissances of the various geologists of Pennsylvania, appear to have sufficiently established the perfect geological identity between the formations of coal under their separate aspects; and the results of the state geological survey put the matter beyond all possible doubt.

We may, however, mention that "the anthracite formation of the United States," is even now regarded by some French geologists as "belonging to the upper portion of the transition series," and is still considered by them as older than the bituminous or true coal formation.‡

The absence of fossil shells in the shales of the American anthracite beds, and their presence in those of the bituminous coal strata, both in the United States and in New Brunswick, have had their influence in leading to the opinion of a difference of geological age in these formations.

STATISTICAL NOTICES OF PENNSYLVANIA BITUMINOUS COAL.

At what precise period the mineral coal of Western Pennsylvania first came into use does not appear. By the treaty of 1758, between the Indians and the Proprietaries, as the Penn family and their coadjutors were then styled, the boundary of their lands extended eastward along the Alleghany or Endless mountains, across Pennsylvania, so far as they range through that state. These lands had been conveyed by the Five Nations, in 1736; but from the vagueness of their definition, had been long a subject of dispute. The whole district, now known to us as the anthracite region, appears to have been confirmed by the Delawares in 1737 and 1749.

According to Mr. Sergeant, the last purchase made by the proprietaries from the chiefs of the Six Nations, was in November, 1768. It enclosed all the area lying south of a line commencing at Owego, on the north branch of the Susquehanna; down to Towanda, and up that creek to the head waters of Pine Creek, and thence down the same and up the Susquehanna to the Indian town of Kittanning on the Alleghany river; and down the Alleghany and Ohio rivers to the south line of the province.§ It will be seen that, with the exception of that portion which lies northward of Kittanning, and which was not purchased until 1784, the proprietaries by this purchase came into possession of the whole bituminous coal-field of Pennsylvania, stretching from Towanda on the north-east, to the south-west angle of the state, a distance of two hundred and seventy miles, besides the northern or Wyoming anthracite region. The cost price or purchase money

* Eaton's Geological Text Book, 1830, pp. 39–43. Map and Sections.

† First Report of the Geology of the State of Indiana, by David D. Owen, 1837, p. 30.

‡ Burat. Du gisement des Combustibles Fossiles, 1846, p. 49.

§ View of the Land Laws of Pennsylvania, by Thomas Sergeant, Esq., 1838, p. 31.

of these magnificent coal-fields appears to have been the sum of *ten thousand dollars* only.*

In the provincial maps, as early as 1770 and 1777, the sites of beds or "mines" of coal were marked on the shores of the Ohio. In the vicinity of Pittsburg the outcrops of coal seams were not noticed, or at least were not made use of until after these dates. In 1753, when the position was first examined by Washington, there was probably no white man living within the limits of the present site of that city; and, in 1775, we are told that there were not more than twenty-five or thirty cabins or houses standing there.†

The value of mineral coal was well known to all who had seen or heard of its employment in Europe; but the abundance of timber in the newly acquired territory rendered the substitution of any other description of fuel quite unnecessary.

Among the first positions where land was acquired from the commonwealth, for the sake of the coal it contained, was one on the upper waters of the Susquehanna, near the present town of Clearfield, and the Indian village of Chincleclamoose, where the horizontal coal seams are very conspicuous. A tract of coal land was taken up and patented here, as early as the 1st November, 1785, by Mr. S. Boyd; but it was not until after the lapse of nineteen years, that a quantity of coal was forwarded eastward of the Alleghany mountain. The first ark load descended the Susquehanna from this place, in 1804. It was sent down by Mr. W. Boyd, and was landed at Columbia, on the Susquehanna, a distance of two hundred and sixty miles; "and it was a matter of great surprise," he observes, in an account of this experiment, "to the inhabitants of Lancaster county, to see an article with which they were wholly unacquainted, brought to their own doors."‡ This movement was followed by more ark loads forwarded by other proprietors from neighboring sites; and, subsequently, a limited trade in bituminous coal has been carried on, along the towns and iron works of the Susquehanna, partly in periods of freshets by means of arks, and partly by canal boats, during the last thirteen years. But it was not until 1828 that the first cargo of Pennsylvania bituminous coal reached Philadelphia from Karthaus, and some was also forwarded to Baltimore from the same source.

From the Congressional returns, obtained during the taking of the census of 1840, it is seen that the bituminous coal-field of this State produced 415,023 tons; employing 1798 workmen, and a capital of $300,416. It is generally supposed, that this return was below the actual production, and it is certainly most disproportionate to the amount of capital.

There will always be great difficulty in ascertaining the bituminous coal production of Pennsylvania, or indeed that of any part of the Alleghany coal-field; because the frontier is extensive, and the avenues from it are numerous, while at the same time there exists no machinery or organization for ascertaining the annual consumption of fuel, for manufacturing or domestic use; particularly in a country where every farmer is at liberty to extract coal for himself or his neighbours.

Anthracite, on the contrary, has but a few channels to market, and these are public routes on which weekly statements of the tonnage conveyed are made, and almost every ton is under supervision and record, between the mine and ship-board. We think that the quantity of bituminous coal mined

* Geography of Pennsylvania. Trego, 1843, p. 19. † Ibid. p. 171.
‡ Journal of the Senate of Pennsylvania, 1834, vol. ii., pp. 481 and 561.

is about a million of tons. It has been estimated at much more, but this is mere surmise. In 1845–6, the quantity of coal received on the Ohio at and near Pittsburg, was reported officially at under 700,000 tons; of which 200,000 tons descended the Ohio to other markets, out of the State. This seems about the proportionate increase since the returns of 1840. Various circumstances are daily contributing to enlarge the demand for coal in the valley of the Ohio; the most obvious of these are the diminution of wood in the vicinity of great rivers; the multiplication of furnaces of iron and salt-works; of steam engines and steam-boats; of manufacturing establishments, and the remarkable accession to population every year.

We have ventured to make an approximate estimate of 1,750,000 tons as the annual production of bituminous coal in the United States—which quantity is more than double the actual return in the year 1840. Of this amount, we have apportioned 1,000,000 of tons as the quantity yearly raised by Pennsylvania. It must be borne in mind, that the bituminous coal-fields of America are still, and probably for centuries will continue, the great forest regions of the country, where mineral fuel, except in the cities, is very little resorted to for domestic uses, and where, at the present day, comparatively but a small amount is consumed by the iron works, steam-boats, &c.

To show, however, the extreme uncertainty, the difficulty, of estimating the actual quantity of bituminous coal raised in Pennsylvania, we may mention that one calculation, which is circulating in the newspapers, gives as the probable amount of bituminous coal mined in this State, in 1847, ten millions of bushels; equivalent to 357,000 tons.

In the absence of the final Geological Report of the State, the reader may peruse with advantage the masterly description of the Aappalachian coal strata, by Professor H. D. Rogers, and the paper on the physical structure of the Appalachian chain, by Professors W. B. Rogers and H. D. Rogers, in the Transactions of the Association of American Geologists and Naturalists, 1843.*

In the first communication it is shown that the coal is distributed "in a series of parallel and closely connected synclinal depressions, the direct result of the system of vast flexures, into which the whole of the Appalachian rocks have been bent, by the undulatory movements that accompanied the final elevation of the strata, and terminated the era of the coal."

EXTENT OF INDIVIDUAL COAL SEAMS.

In the article from which the last paragraph is quoted, are some very interesting facts on the great extension of certain coal seams in the Appalachian system. We have no space here, to do justice to this truly philosophic memoir. We must restrict ourselves to citing a single example. This is the great seam which is finely exposed at Pittsburg, and along the Ohio and Alleghany rivers, and nearly the whole length of the Monongahela, and is denominated "the Pittsburg seam." With the advantage of competent assistance, the author has traced this bed through Pennsylvania, Virginia, and Ohio. "The longest diameter of this great elliptical area is very nearly two hundred and twenty-five miles, and its maximum breadth is about one hundred miles. The superficial extent of the whole coal seam, as near as I can estimate it, is about fourteen thousand square miles." But these limits, he continues, though wide, fall very far within those which the bed an-

* Pp. 433 and 474, 531.

ciently occupied, which "must have been at least thirty-four thousand square miles;—a superficial extent greater than that of Scotland or Ireland."

If, as the writer conceives is probable, and in which we entirely coincide, this seam is identical with the great bed which occurs in all the anthracite basins of Pennsylvania, "we shall then behold, in all its conditions of gradation, from anthracite to semi-bituminous, and to highly bituminous coal, a single stratum measuring at the most moderate calculation, four hundred and fifty miles in length, and two hundred miles in breadth, and covering a space of at least ninety thousand square miles."

The author has, with much ability, traced the regular gradation which this remarkable bituminous coal bed experiences in size; diminishing gently from south-east to north-west:—that is to say, from twelve or fourteen feet thick on the south-eastern border, to eight feet at Wheeling and Pittsburg; and, still more westward, in Ohio, to five or six feet.

LOCAL STATISTICS.

It would be altogether inconsistent with the plan of the present work to enter upon the details of individual coal operations throughout this area. Many of these will be found adverted to in the annual geological reports of this district, particularly as relates to the region west of the Alleghany range.

Towards the northern and north-eastern side of this range, the seams seldom attain a greater thickness than three or four feet. In the vicinity of Philipsburg, and along the valley of the Moshannon to its head waters, several good coal beds appear. Three of these are from four to four and a half feet thick each, and one main seam is, including some slaty partings, nine feet thick. A detailed section of this local district, crossing the Alleghany Mountain to the Bald Eagle valley at its base, was published by the author of the present volume, in the year 1832, in the Monthly American Journal of Geology, conducted by Mr. Featherstonhaugh. We believe this was the earliest geological section, in detail, of any portion of the Alleghany Mountain, and of the coal-field overlying its eastern escarpment.* Mr. McClure's transverse sketches, can scarcely be said to form the exception. This section was reconstructed from accurate admeasurements and actual levelling, on a greatly extended scale, in the succeeding years 1833 and 1834.

Near Karthaus, eight coal seams have been traced, amounting to twenty feet thickness; but three only of these are workable—the largest being six feet.†

Near Farrandsville and Queen's Run, two beds of three or four feet each, have been worked for some years. This coal is in good repute, but of limited area. At Ralston, and in the detached small coal basins which border the Lycoming creek, the coal measures occupy a comparatively small thickness. The two principal seams have about eight feet of workable coal. There are commonly four seams, altogether, existing within the formation in the north-east extremity of the Alleghany coal-field; but it is seldom that more than two workable beds occur in the same locality. This region has been minutely investigated by the present writer, at various periods since the year 1831. The coal is well adapted for iron making.

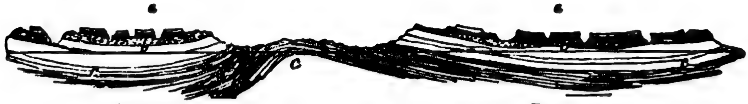
At Blossburg, and around the head waters of the Tioga river, from three to six seams occur, but not more than one or two have been mined, and

* Monthly American Journal of Geology, Vol. I. p. 433.
† Report to the Clearfield Coke and Iron Company, 1839. W. R. Johnson.

the coals are sent by railroad into the state of New York. One of the beds, at one point, appeared to be six feet thick, but in general the seams are about three feet each. A geological survey of this region was made by the writer in 1832; and, at subsequent periods it has formed the subject of several communications to scientific journals. In 1831–2, the country was then in a state differing little from the primitive wilderness; but time has changed its aspect, and a large amount of business and travel is said to be done here. Few districts have been more fully illustrated, geologically, than that of Blossburg,* and in many respects it is very interesting to the geologist and the naturalist.

Fig. 4.

Transverse Section of detached Bituminous Coal basins in Pennsylvania.



a a Coal measures.
b b— Old red sandstone or Devonian.
c Devonian System Chemung group.

Generally speaking, the bituminous coals of the north-east end of the great Alleghany coal-field, here subdivided into numerous small detached coal basins and outlying patches, consist of dry coals, yielding a considerable per centage of grey ashes; burning with but little tendency to cement or cake in the open fires, and yielding not much smoke. Sometimes rather sulphurous. We might employ a familiar mode of comparison with the fat coals of England, and perhaps those of Western Pennsylvania and Virginia, in remarking that, in their domestic use, the former never accumulate a sufficient quantity of soot to render the sweeping of chimneys necessary; they remain comparatively clean, for many years together.

The Lycoming, or Ralston basin is illustrated by the last section, which shows its relative connection with the Blossburg basin. This Lycoming basin consists of two areas, separated to the depth of one thousand feet, by the valley of Lycoming creek. The coal and iron ore beds are open here, on both sides, but the present amount of business is but small.

PRODUCTION AND CONSUMPTION OF BITUMINOUS COAL AT PITTSBURG.

Besides the main bed of workable coal at Pittsburg, which is there about six feet thick, there is another seam of less value, on account of the intermixture of slate that it contains. These are considerably above water level. It has been ascertained, during the process of boring for salt water, in the vicinity of Pittsburg, on the opposite side of the Monongahela river, that four good seams, besides two small ones, lie at a considerable depth below the surface. The whole depth bored was six hundred and twenty-seven feet. The four coal beds were each about three feet and a half in thickness, and were reached at the respective depths of two hundred and eighty, four hundred and forty, four hundred and eighty, and five hundred and eighty

* Mineralogical Report on the Coal Region in the environs of Blossburg, R. C. Taylor, 1832. Trans. Geol. Soc. of Pennsylvania, on the coal-field of Blossburg. R. C. T. 1835. Magazine of Natural History, Vol. VIII. p. 529; London, 1835. R. C. T. Philosophical Magazine, London, 1836. R. C. T. Penny Mag. London, do. American Journal of Science, Vol. XLI. No. 1. Section across the Blossburg and Lycoming Coal Basins. Section across the Towanda and Loyalsack Coal Basins. R. C. T. July, 1841. Trans. Assoc. of American Geelogists and Naturalists, 1843, Art. by R. C. T.

feet. Gas was evolved from each of these veins, and continued to discharge for three or four weeks. The salt water was reached at six hundred and twenty-five feet, and rose to the height of thirty feet above the surface; discharging at the rate of seven thousand gallons in twenty-four hours.

This city and the manufacturing establishments in the vicinity, form the great focus for the consumption of bituminous coal in this state.

In the year 1825, it was estimated at one million of bushels, or 35,714 tons. In 1833, it was returned [in bushels] at 255,910 tons—there being ninety steam engines in operation.* In 1834, eighteen iron foundries, eleven rolling mills, and one hundred and twenty steam engines were at work at Pittsburg and its environs. In 1838, the consumption, by engines and the advance of manufactories had greatly increased, there being now three hundred steam engines and as many factories.† In a communication to a Congressional committee on a national foundry, in that year, it was announced that the quantity of coal consumed was seven millions of bushels per annum, and of that exported three millions of bushels; in all ten millions of bushels, or 357,140 tons, of 2240 lbs.; each bushel weighing eighty lbs.‡

It was computed, in 1842, that the consumption in Pittsburg alone had now risen to eight millions of bushels—or 285,714 tons; the aggregate production at the same time, being 420,000 tons. The number of steamboats owned in the district was eighty-nine, of an aggregate tonnage of 12,436 tons.§

In the annual message of the Governor of Pennsylvania, January 1846, we find it announced that the consumption had reached the following amount:

	Bushels.	*Tons.*
Consumed in Pittsburg and its vicinity,	13,000,000	464,286
Exported from that port down the Ohio,	6,000,000	214,286
Production,	19,000,000	678,572‖

The progress of improvement may be noted in relation to the advance of population.

1753,	No white man living here.	
1813,	Population of Pittsburg,	5,748 persons.
1848,	" " about	50,000 "

In the year 1846, were built fifty-three steamboats, which cleared from the wharves at Pittsburg, having an aggregate tonnage of 8551 tons, and costing $684,000.

In 1847, fifty-six more steamers were built, whose tonnage was 9954 tons.

The tonnage owned in Pittsburg, on the 1st September, 1847, was as follows:

Steam tonnage,	24,472
All other kinds,	2,546
Total,	27,018

* Journal of the Senate of Pennsylvania, 1833, p. 482.
† Proceedings of the Union Canal Convention at Harrisburg, in 1838, p. 12.
‡ Report of the Committee on a National Foundry, 1838, p. 60.
§ Geography of Pennsylvania, from Harris's Directory.
‖ Message of Governor Shunk, 7th January, 1846.

Thus rapidly did this city spring up in the wilderness. Her population now employs more than twenty millions of capital in these active pursuits; and communicates, by means of fifty thousand miles of steam navigation, with almost every part of the valley of the Mississippi.*

FROSTBURG BITUMINOUS COAL REGION.

EXTENSION NORTHWARD INTO PENNSYLVANIA.

We will complete our notice of this detached or frontier coal area by adverting to its small peninsular extension into Pennsylvania.

In the absence of the official geological reports, wherein the boundaries may be expected to be defined, we can only roughly estimate this at about 25 square miles, of actually available coal land.

In the details of the coal seams there is little difference on either side of the State line. From various statements, we are apprised that about ten yards of coal may be calculated upon, within the area we have mentioned.† Assuming this to be correct, and that it extends beneath that entire surface, there are in the ground 750 millions of tons of coal on the Pennsylvania side. But the basin form arrangement of the strata, and the reduced area occupied by the upper beds, seem to forbid this process of calculation, and to demand a considerable deduction, into the details of which it would be profitless to enter here.

The expense of mining and conveying this coal to tide, was calculated at $3.81 per ton, exclusive of the profits to the landowner, and his lessee, the merchant, &c., and interest of capital. The Special Report of the Chesapeake and Ohio Canal, Nov. 16, 1843, estimates the cost to tide $3.17.‡ It is contemplated, however, independent of the large expected sale of the coal on the seaboard, to employ it on the spot in the manufacture of iron, for which, from its excellent properties as an intermediate quality between the fat coals and the anthracites, it seems to be well adapted, and is eminently entitled to consideration.

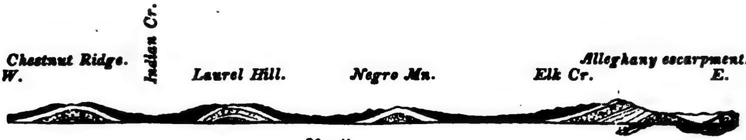
See our account of these coals in the Maryland division.

NORTH-WEST FROM FROSTBURG.

The coal region in this part of the Alleghany Region, has been detailed in Transactions of the American Geologists, &c., in 1842, in a memoir on the Physical Structure of the Appalachian Chain, by Messrs. Rogers. The following sketch is reduced from the section which illustrates that memoir.

Fig. 5.

Section across the eastern portion of the Alleghany Coal-Field, in Pennsylvania, showing the undulations or gentle flexures of that region.



* Hazard's Register of Pennsylvania, Vol. XVI. p. 22.

† Report to the Alleghany Coal Company, in 1841, W. R. Johnson; and Reports of other Coal Companies in the vicinity of Frostburg. Also third annual report of H. D. Rogers.

‡ Special Report of the Pres. and Dirs. Ches. and Ohio Canal Co., 16 Nov. 1843, p. 17.

CANNEL COAL.

Near Greensburg, in Beaver county, Pennsylvania, is a bed of Cannel Coal, about eight feet thick, resting upon three feet of ordinary bituminous coal. This Cannel is light, compact, ignites with great facility, and burns with a strong bright flame.*

A similar quality of coal is found in Kentucky, Ohio, Illinois, Missouri, Indiana, and, we believe, in Tennessee. It is not commended for any purpose of iron making and manufacture, but is well approved of for steam engines.

STATISTICS OF BITUMINOUS COAL PRODUCTION.

PENNSYLVANIA COALS DESCENDING EAST.

Cumberland Bituminous Region commencing at the south-west angle of that portion of the State whose market for coal lies at the seaboard, we have little to report upon its supply heretofore; as the facilities of transportation by canal and railroads are only now brought to completion, and the amount of trade is therefore prospective, merely. The high reputation that this coal enjoys will secure it a ready sale, and even a preference; if the coal merchants can furnish it at reasonable rates. These coals will be conveyed from the south-west Pennsylvania collieries to the Atlantic, through the State improvements of Virginia and Maryland.

The Chesapeake and Ohio Canal will, it is probable, be complete in the course of the year 1849, when a large amount of coal business will, it is calculated, be the immediate result.

By the Pennsylvania State Canals, from the Alleghany Coal-field.

		1843.	1844	1845.
		Tons.	Tons.	Tons.
JUNIATA,	Shipped and sent East from Hollidaysburg	14,510	19,000	25,319
	Retained at Hollidaysburg,		330	459
WEST BRANCH CANAL,	Dunnsbury,	5,448	10,475	12,415
	Williamsport,	2,464	1,110	625
		22,422	30,915	38,818

There being no other outlets for the bituminous coal, to the eastward, with the exception of the small district near Cumberland, than through the State improvements, it is probable that the above statement very nearly represents the aggregate which is shipped in this direction from the Alleghany coal region. A large portion of this is deposited, on the route, at the iron works and towns of the interior.

The distribution of the remainder, for the use of the cities on the seaboard, is, for the most part, through the following channels.†

* Trego in the Geography of Pennsylvania, p. 179.

† From the annual Reports of the respective companies enumerated in the table, and also from the Canal Commissioners' Reports. Also Hunt's Merchants' Mag., Aug. 1845, p. 186.

Returns in bushels and pounds reduced to the common denomination of tons of 2240 lbs.

Years.	Shipped East at Hollidaysburg.	Shipped by the W. Br. Canal.	Rec'd. at Northumberland.	Sent by Union Canal.	By Tidewater Canal.	By Delaware and Chesapeake Canal.	Arrived in Philadelphia by water.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1843		7,912		2,079	3,923		
1844	19,000	11,585	657	1,705	7,547	6,114	
1845	25,319	13,040	853	2,650	11,963	11,291	
1846				2,400	12.438		
1847				2,702		6,334	1,058

Consumption of Coal in the Glass Manufactures of the United States.

In 1846, by a report on the subject, it is shown that in the 19 establishments for making flint glass in the United States, there are annually consumed as follows.

	Tons.
Bituminous coals, chiefly Pennsylvania and Virginia, and $\frac{1}{25}$ part only foreign, - - - - - - - - -	44,640
Pennsylvania anthracite, - -	5,500
Total	50,140

Besides 8,666 cords of wood.

Importation of Foreign Bituminous Coal into Philadelphia, from Great Britain and the British Provinces.

Years.	Bushels.	Tons.	
1833	84,510	3,018	The respective proportions of quantity are as follows:
1834	51,286	1,831	Received from Great Britain, 6,733
1835	10,056	359	" Nova Scotia, 43,026
1836	145,904	5,211	Tons, 49,759*
1837	140,362	5,013	
1838	274,282	9,792	
1839	406,081	14,508	
1840	36,195	1,292	
1841	244,588	8,735	

Of late years there have been no foreign importations of coal.

Importation of Virginia coal into the Port of Philadelphia, in 1847. During this year there were measured, 268,790 bushels = 9,600 tons.†

BITUMINOUS COAL DESCENDING WEST.

The coal business of the Monongahela slackwater Navigation, in the year 1845, as partially shown by the amount which passed through Lock No. 1, to Pittsburg, was

1845 2,657,488 bushels = 95,000 tons of 28 bush. each for Pittsburg.

1846 { 2,575,375 bushels = 91,977 tons do. for the use of the city.
5,206,495 bushels = 185,930 tons do. for the lower trade, or for export down the Ohio.

* Hazard's United States Register, 1839.
† Bicknel's Reporter, Jan. 4th, 1848.

RECEIVED ON THE OHIO.

Bituminous coals received on the Ohio, at and near Pittsburg, chiefly down the Alleghany, Ohio, and Monongahela rivers and their tributaries, estimated for the year 1845, at 678,572 tons.

A small but increasing amount passes down the Western Division of the Pennsylvania Canal, to Pittsburg.

1843	973 tons.
1844	1360 "

BITUMINOUS COAL GOING NORTH.

From the detached coal-field of Blossburg, near the head of the Tioga river, a railroad of forty miles conveys about 30,000 tons annually to the Chemung canal, at Corning, in the adjoining State of New York. This coal-field is capable of supplying at least 100,000 tons per annum, for a long period of years.* Its business, at no time in a state of much activity, appears now to be on the increase, and its advance is greatly facilitated by the recent reduction of tolls on the State canals of New York.

These are now reduced to only 2¼ mills per ton of 2240 lbs. per mile; and for all coal conveyed for the use of the salt works, the chief destination of the Blossburg coal, toll free. This forms a striking contrast to the toll on mineral coal in Pennsylvania, which is no less than 4 mills 4 dec. per ton per mile on canals, and 6.7 mills on railroads.

From the detached coal field near *Towanda*, a comparatively small supply passes northward, under the present condition of the public improvements. These being perfected, will soon become the channel for the conveyance of a considerable annual amount of bituminous coal into New York State.

Exports of Pennsylvania Bituminous Coal from the Port of Erie, via Lake Erie.

		Tons.	*Value.*
	1845	8,507	$21,218
	1846	21,534	53,835
Received at the port, 70,000 tons,	1847		

Exports northward from the Blossburg Bituminous Coal Region.

The demand for this coal increases, and we are assured that its quality, as it penetrates the mountain, improves.

The railroad company received toll, in 1847, for - -	29,110 tons,
To which may be added for domestic consumption, by the locomotives, machine shops, &c.	1,000 "
Total in 1847,	30,110 tons.

* Mr. R. C. Taylor's Blossbury Report, in 1832.

Rates of Toll on the State Canals and Railroads in Pennsylvania, per mile, in 1846, 1847.

	On Canals. Cents.	On Canals. Mills.	On Railroads. Cents.	On Railroads. Mills.
Mineral Coal, Gypsum, and Iron ore, } per 1000 lbs. weight,	0	2	0	3
Which rate is equivalent to per ton of 2240 lbs.	0	4.4	0	6.7
Each 100 miles of transportation, therefore, is	44	8	67	2
On each Union Canal boat, engaged in the coal trade, per mile,	1	0		
State of New York—1846.				
Toll on the State Canal,—on Mineral Coal, per 1000 lbs. per mile,	0	1		

In a report of the president of the Chesapeake and Ohio Canal Company, in 1843, the estimated prime cost per ton of the Cumberland coal, delivered in New York is $1.67.*

In 1844, Alleghany bituminous coal sold at from 16 to 18 cents per bushel = $4.50 to $5.00 per ton, in Philadelphia; brought 210 to 250 miles by canals.

During a portion of 1845, bituminous coals from the interior obtained no higher price in Philadelphia than 14 cents per bushel: but towards the close of the season the largest sales were effected in this city at 21 cents per bushel = $5.75 per ton of 2000 lb.; the cost of the freight and toll being $2.62½ per ton, from Farrandsville and the adjacent mines, to Philadelphia.

In the winter of 1846–7, Alleghany coal, in Philadelphia, was 18 to 19 cents per bushel; Virginia coal, 20 to 22 cents per bushel. This being on a very small scale, is naturally very fluctuating. The current price of Alleghany coal, in Philadelphia, in the winter of 1848, was 25 cents per bushel, or $7.00 per ton.

The external trade, coastwise, in this coal is quite unimportant.

Boston, in 1846, received but 4900 bushels = 175 tons, from Philadelphia, and can purchase Nova Scotia coal on much lower terms.

THE ANTHRACITE REGIONS OF PENNSYLVANIA.

INTRODUCTORY REMARKS.

It has heretofore been customary to describe the Pennsylvania anthracite fields as occupying three distinct, yet corresponding areas. These are familiarly spoken of as, I. The Schuylkill or Southern coal region; II. The Middle coal region; and III. The Wyoming, Wilkesbarre, or Northern region. At the present day, they, particularly the middle district, are

* Special Report of the President and Directors of the Ches. and Ohio Canal Co., Nov. 16. 1843. Also, Report of the probable revenue of the Ches. and Ohio Canal. 1834, p. 40 "To quarry this coal," says another authority, "costs about 20 cents a ton." See American Quarterly Review, March, 1829.

known to consist of a great many separate or subordinate basins. Any attempt of ours, in this place, to unravel the local intricacies of this series of coal basins, would but complicate a description which we design only to be general. Fortunately, their investigation has been committed, by the commonwealth, to able hands; and the results, we anticipate, will be of a useful character. Until these are before the public, it seems advisable to adhere to the old local classification; and in continuing, for the present, the order heretofore observed, although obviously defective, we shall perhaps best consult the convenience of our readers.

During the last twenty years the anthracite deposits of Pennsylvania have acquired no small celebrity. They have attracted towards them a larger amount of capital than ever before was invested in mineral operations in the United States; and, consequently, have called into exercise a corresponding amount of productive industry. One result of this state of activity, is, that able geological investigators, and writers of intelligence have by no means been wanting to demonstrate, not alone to the proprietors, but to the commercial and manufacturing interests, and to the scientific world, the enormous value of these concentrated resources. To Pennsylvania, the almost exclusive possession of this species of combustible, within reasonable distance of the seaboard, is a boon of inestimable price, which places her in a position of enviable superiority, and baffles speculation as to the point, to which it may ultimately elevate her. The statistical details, scattered through the following pages, justify such conclusions, notwithstanding that the financial difficulties by which the country was beset, a few seasons ago, deeply affected the best interests of the state; and somewhat retarded the progress of improvement in the anthracite regions, in common with that of all others. Happily, that period of gloom and depression has at length passed by, and energy and enterprise have succeeded to apathy and despondency.

HISTORY AND PROGRESS OF ANTHRACITE PRODUCTION.

With the exception of three or four detached basins or patches, of very limited extent and value, in other states, Pennsylvania is the great depositary of anthracite, on the North American continent. The entire area is made up of a numerous suite of coal basins, produced by alternations of anticlinal and synclinal axes, which range nearly parallel with the base of the Alleghany mountain. An acquaintance with the extent and number of these separate little coal troughs has only been acquired after years of investigation; and in fact is, even now, very far from complete. As in the case of the bituminous coal-fields of this state, it is much to be desired that the state geological report and map should be published, and that the public should, after the lapse of twelve years from the commencement of the survey, derive some benefit from that important work.

Allusion has already been made to the geological age of the anthracite districts, and to its obvious agreement, in that respect, with the bituminous series. Respecting this point, it is remarked by one of the best authorities in the science, that these deep anthracite basins, abounding in curious structural features, and containing thick seams of coal, are highly interesting by the geographical position which they occupy. "More than forty miles distant from the general denuded margin of the main or western coal-field, they nevertheless present, in the character of their strata, and of the rocks, upon which they repose, unequivocal evidence that they and the

bituminous basins were once united."* But it is worthy of note, that at the north-eastern extremity of the bituminous coal area of the Alleghanies, it approaches within ten miles only of the Wyoming coal basin, which contains the hardest species, of white ash anthracite. In the map, which we annex, we have been able to point out this proximity, accurately.

Passing now to the historical development of resources so valuable to the interests of Pennsylvania. In 1749, the lands between Mahanoy creek on the east side of the Susquehanna river, and the Delaware north of the Blue mountains, were obtained from the Indians; apparently, in part or the whole, the present counties of Dauphin, Schuylkill, the south parts of Northumberland, Columbia, and Luzerne; Northampton, Monroe, and Pike.† The space thus defined comprehends the lands between the Blue or Kittatinny mountain range to the south, the Susquehanna to the west, and a line drawn from the point of the mountain at the mouth of Mahanoy creek to the mouth of Lackawaxen creek, at the New York state boundary, and at the junction of that creek with the Delaware river; being one hundred and twenty-five miles long, and thirty miles average breadth. All this little territory of 3750 square miles embraces the entire group of anthracite basins, which are comprised in what are usually styled the southern and middle coal-fields, and the whole was transferred by the Indians to the proprietary government, for the sum of *five hundred pounds*. From the same territory has been acquired, within the last quarter of a century, nineteen millions of tons of coal, of the value of seventy-five millions of dollars; and in the production and disposition of which fifty thousand persons derive their support.‡ In the year 1847, three millions of tons were brought to tidewater, whose value there was twelve millions of dollars.

In the purchase made by the proprietaries, in 1768, by which they acquired from the chiefs of the six nations the bituminous coal-fields within the state, they became also owners of the northern, or Wyoming anthracite basin; the value of which, at that time, was very little anticipated by either of the parties to the contract.

From all that we can now trace, it would seem that anthracite was first observed, and its combustible properties tested, in this northern district, in 1768. On the authority of an article in the "Memoirs of the Historical Society of Pennsylvania," the adaptation of this newly observed substance to the purposes of fuel, was discovered by certain blacksmiths, about the year 1770, two years only, after the ratification of the treaty of purchase, and three years previously to the laying out of the borough of Wilkesbarre, by the Susquehanna Land Company of Connecticut. The first cargo of this coal was sent down the Susquehanna, in boats, and reached the U. S. armory at Carlisle, in 1775: but it was not until 1808, that grates were constructed at Wilkesbarre, to burn it for domestic use, under the direction of Judge Fell.§ It is very probable that the fine natural sections of the coal measures in this valley, occasioned by the cutting of the river Susquehanna through its margin, at two points, and the deep lateral ravines which also laid bare the thick bed of coal along its borders, were the means of displaying the carboniferous strata, and, as now, facilitated their developement, at so early a period. Not less than three millions and a half or pro-

*** Origin of the Appalachian coal strata. By Prof. H. D. Rogers—in Trans. Assoc. Amer. Geol. and Nat. 1843, p. 436.**

† View of the Land Laws of Pennsylvania. By Thos. Sergeant, Esq. 1838, p. 30.

‡ Speech of Mr. Ramsay in Congress, April 29, 1844.

§ Memoirs of the Historical Society, Vol. II. p. 154. Art, by Erskine Hazard, Esq.

bably four millions of tons of anthracite have been sent to markets on the seaboard from hence, since the year 1829. The latter year was the commencement of the coal works at Carbondale.

In the Schuylkill division of what has been customarily called "the southern coal region," anthracite appears to have first attracted the notice of the scanty population, settled near the present site of Pottsville, about the year 1790.* It is extremely probable, that an obscure knowledge of its existence, and an undefined surmise of the combustible properties of this mineral substance, had existence some years earlier; especially as it had been seen, and partially tested, and had been spoken of in the Wilkesbarre district, for twenty years previously. The number of emigrants who arrived in the country, and who were accustomed to the use of coal, also facilitated the knowledge of this description of fuel.

We are the more confirmed in this opinion from having seen a large map of Pennsylvania, published in 1770, from Scull's older map, in which the site of "Coal" is marked, and shown to prevail about the head waters of Schuylkill creek, and stretching thence westward, to those of the Swatara, and to "the wilderness of Saint Anthony."

Near the eastern extremity of the same southern region, on the lofty ridge which overlooks the valley of the Lehigh, anthracite was accidentally discovered in an enormous mass, open and bare to the very surface. This occurred in the year 1791. It was the first knowledge of the now celebrated Mauch Chunk mines, which, even at the present day, are worked as an open quarry. Having purchased from J. Weiss the newly found site of the "Summit Mines," the "Lehigh Coal Mine Company" was formed in 1793, for the developement and working of this unproved combustible; but it was not until 1814, that the first twenty tons were conveyed down the Lehigh and the Delaware rivers, at great labour and cost, to Philadelphia, where a few wagon loads had preceded them, from the Schuylkill district, in 1812. It was as late as the year 1820 before the comparatively large quantity of 365 tons of anthracite reached their destination at Philadelphia.

The first volume of the Memoirs of the Historical Society of Pennsylvania contains "a brief account of the discovery of anthracite coal, on the Lehigh," from the pen of T. C. James, M.D., which was read on the 19th of April, 1826. The author states, that in the autumn of 1804, having, in company of a friend, crossed the Blue Mountain, they found themselves bewildered in a secluded part of the Mahoning valley, and at length obtained shelter for the night, at a solitary mill, kept by Philip Ginter. This was the individual who discovered the coal on the Mauch Chunk mountain, and who conducted Dr. James and his companion to the spot where is now the open mine, or rather quarry, of anthracite.

"At that time there were only to be seen three or four small pits which had much the appearance of rude wells, into which one of our guides descended with great ease, and threw up some pieces of coal for our examination. After which, whilst we lingered on the spot, contemplating the wildness of the scene, honest Philip amused us with a narrative of the original discovery of this most valuable of minerals, now promising, from its general diffusion, so much of wealth and comfort to a great portion of Pennsylvania. His only resource being that of a hunter in the back woods, he was, on the occasion alluded to, returning, towards evening, over the Mauch Chunk mountain, entirely unsuccessful and dispirited, having shot nothing. As he

* Packer's Report in Senate Journal, Vol. II. 1833–4.

trod slowly over the ground, his foot stumbled against something, which, observing to be black, he took up. Having listened to the traditions of the country respecting coal in the vicinity, it occurred to him that this, perhaps, might be the "Stone-Coal" of which he had heard. He accordingly, on the next day, carried it to Colonel Jacob Weiss, who, being alive to the subject, brought the specimen immediately to Philadelphia."*

The result was the formation of a company to work the newly discovered coal, which, however, was neglected until 1806, when two hundred or three hundred bushels were brought down; but, not being understood, it failed to give satisfaction, and the enterprise was again suspended for several years. The writer closes his communication by stating, that he commenced burning the anthracite coal in the winter of 1804, and had continued the use of it until that time, 1826; "believing, from his own experience of its utility, that it would ultimately become the general fuel of this [Philadelphia] as well as some other cities."

The Mauch Chunk Railroad, of nine and a half miles, was begun January 12th, 1827, and was finished in May, of the same year, since which time the whole mountain has been intersected by railroads, tunnels, inclined planes, schutes, and numerous other works, and contains a large population of operatives.

The "Middle Region" is the most complicated of the three, being made up of a series of axes of elevation and depression; in the troughs of which thick bodies of coal occur, which, even now, are but imperfectly explored, but become subjects for investigation in proportion to the gradual advance in the demand for coal, and consequent increase in the value of those tracts of land which are so fortunately situated as to contain it. From its wild, mountainous, and inhospitable character, unattractive to settlers and little adapted to cultivation, this district was the last to make known its buried treasures; as, owing to the natural difficulties of approach, it was the latest to become the theatre of industrial operations. The progress of geological discovery was still farther retarded by the prevailing ignorance of the elementary principles of stratification, deposition, and extension of coal seams; each exposure of mineral coal being conceived to be, and treated as an isolated mass and a local deposit; such, for instance, as that on the summit of Mauch Chunk was long considered to be.

Yet the proprietaries were not altogether ignorant of the existence of coal within these limits, for we have seen, in the large North American Atlas, published by Faden, of London, in 1777, from an earlier map of 1770, that coal pits or mines are marked in the neighbourhood of Mahanoy Creek, above Crab Run.†

Passing from these early notices, we find that the coal trade of Pennsylvania, which had its beginning in 1820, had, in 1833, already arrived at a magnitude so much beyond anticipation, that the Senate of the commonwealth considered it expedient to appoint a committee of inquiry, and to invest it with powers to investigate extensively into the subject.

That committee appears to have most sedulously applied itself to the duty assigned. The report produced by its chairman, Mr. S. J. Packer, exhibits evidences of great care and labour. It concentrates a multitude of local and statistical facts, then for the first time presented to the public; and deservedly merits the eulogium which we desire to bestow upon it. The ground and the subject matter were comparatively new, although the inter-

* Abbreviated from Dr. James's paper, in Memoirs, Vol. I., p. 316.

† Atlas of North America, Faden, London, 1777, from Scull's Map of Pennsylvania, 1770.

ests involved were considerable. The difficulty was enhanced by the uncertainty or complicated character of some of these interests, at the time. We believe it was nevertheless conceded, on all sides, that this document,—the earliest official report on the coal business of Pennsylvania, or indeed of that of any portion of the United States,—was drawn up with ability and perspicuity, and evinced much practical good sense. Superseded as it now is, or inevitably must soon be, by the mature developments of more recent times; by laborious private investigations; by highly accomplished observers; and, beyond all, by the results of the state geological surveys, under the zealous superintendence, during many years, of one of the ablest geologists of the day, yet the report of Mr. Packer, in 1834, will never be thrown aside as useless. Although, strictly speaking, not scientific, but illustrated in the coarsest manner, it will always be regarded as a business-like memorial,—adapted to the times and circumstances,—and a valuable contribution to the mining and statistical information of the day. In fact, it belongs to, it is identified with, and greatly illustrates, the commercial and industrial history of Pennsylvania.

In succeeding years, detached notices, both practical and scientific, of local sections of the anthracite coal basins, have appeared in various cotemporary publications. Among these we name Silliman's American Journal of Science; the Transactions of the American Geological Society; the Monthly American Journal of Geology; the Journal of the Franklin Institute; the Transactions of the American Philosophical Society; the Journal of the Academy of Natural Sciences; the Miner's Journal, and the Anthracite Gazette, both of Pottsville; the Commercial List, of Philadelphia; the Mining Journals, of London and New York; the Mining Review; the Transactions of the Geological Society of London; the Transactions of the Association of American Geologists; the Annual Reports of the State Geologist; and several other occasional and local authorities. All these have been extensively quoted by that portion of the public press, including the Registers and Magazines, which is more especially devoted to the circulation of useful, practical, and statistical information.

Among the class of periodicals and occasional documents, not strictly scientific, yet comprising authentic communications of a business character, may be named the numerous annual reports of companies, committees, and associations, and of the State Legislature and of Congress, bearing upon the staple products of Pennsylvania; their avenues to markets; their modes of transportation, both internal and coast-wise; their adaptation for domestic consumption; and, finally, the facilities they furnish to manufacturing enterprise. We advert to this temporary and commercial literature, because of its remarkable diffusion, its cheapness, its influence, and its employment, in this country, to an extent unknown in any other part of the world. It forms an economical substitute for books of a more expensive and pretending character, and may be found in every man's hand.

GENERAL CANAL AND RAILROAD SYSTEM OF PENNSYLVANIA.

	CANALS. Miles.	RAILROADS. Miles.
Those of the State,	848	118
Those belonging to Companies,	432	602
Private Railroads to Mines and under ground,		135
	1280	855

CANAL AND RAILROAD SYSTEM IN RELATION TO THE ANTHRACITE DISTRICTS OF PENNSYLVANIA.

The following table shows the principal state and private Canals and Railroads which are in direct communication with the anthracite mines of Pennsylvania, and which were constructed almost entirely for the purposes of the coal trade, since the year 1821. We believe that this statement is below the actual result, and might be materially increased, independently of the capital invested in the mines and in the coal operations of this important region.

Names of RAILROADS AND CANALS.	Canals.		Railroads.		Total Cost. Dollars.
	No.	Miles.	No.	Miles.	
Lehigh Navigation,	1	87½			$4,455,000
Lehigh and Susquehanna Railroad,			1	20	1,350,000
Mauch Chunk and Summit Railroads, &c.			1	36	831,684
Delaware Division of the Penn. Canal,	1	43			1,734,958
Beaver Meadow Railroad,			1	26	360,000
Hazelton Railroad,			1	10	120,000
Buck Mountain Railroad,			1	4	40,000
Summit Railroad,			1	2	20,000
Delaware and Hudson Canal—partly in N. Jersey,	1	108	1	16	3,250,000
Morris Coal Canal, in New Jersey,	1	102			4,000,000
The Schuylkill Navigation,	1	108			5,785,000
The Reading and Pottsville Railroad,			1	98	11,590,000
Little Schuylkill and Tamaqua Railroad,			1	20	500,000
Mine Hill and Schuylkill Haven and Extension, to Swatara,			1	55	550,000
Danville and Pottsville, 44½ m. unfinished,			1	29½	680,000
Mount Carbon Railroad,			1	7	155,000
Do. and Port Carbon Railroad,			1	2½	120,000
Schuylkill Valley Railroad,			1	14	300,000
Mill Creek Railroad,			1	6	120,000
Railroads by individuals,				70	180,000
Under-ground Railroads,				60	75,000
Lyken's Valley Railroad,			1	16	200,000
Wisconisco Canal,	1	12			370,000
Swatara Railroad,			1	4	20,000
North Branch Canal—division,	1	73			1,491,894
Do. extension,	1	90			1,298,416
Wyoming Improvements, not ascertained,					
	8	623½	17	436	

There are many private railroads, constructed since the above was drawn up. The whole may be estimated at more than forty millions of dollars.

PENNSYLVANIA ANTHRACITE.

COMPARATIVE ADVANTAGES OF ANTHRACITE OVER BITUMINOUS COAL, FOR DOMESTIC PURPOSES.

The author of the work on "*Fossil Fuel*," devotes a page or two, with great propriety, to the subject indicated above, and, if our space permitted, his views should be introduced, without curtailment here. He observes, that "the smoke given off, during the combustion of flaming coal in most large towns, especially the prodigious volumes of it emitted from the chimneys of manufactories, form a serious annoyance in many situations." We must quote a passage on the smoky nuisances attendant on the consumption of this fuel in London and other English cities, agreeing as we do in many, although not all, of the opinions of the author.

"A very striking contrast to the murky exterior of some of the large towns in this country, [England,] is presented by the appearance of the city of Philadelphia, over which, notwithstanding its thousands of coal fires, constantly kept up, there is no smoke. The inhabitants mostly burn the anthracite, a substance resembling the stone coal, or culm, of Wales; the carbonaceous or stony coal of Kilkenny; the glance coal of the Germans; and the blind coal of Scotland.

These coals are difficult to kindle; [no difficulty at all to a Philadelphia housemaid;] but when once thoroughly ignited they burn for a long time; [upon the admirable principles which experience has suggested, whether for open grates or for the infinite variety of stoves and furnaces common to all the houses in Philadelphia, New York, or Boston;] they make a hot glowing fire, like charcoal, without either flame or smoke."

The author goes on to account for the non use of anthracite in Great Britain, which possesses a far larger area of anthracite than exists in America, or any other part of the world.

"It is owing to these coals commonly emitting noxious vapours that they cannot be pleasantly used in dwelling-houses in this country, though they are in considerable demand among malsters, dyers, &c.; more especially for the furnaces of steam-engines and breweries, in those situations where smoke is a nuisance."

And what habitable place is there, among communities of men, not even we believe excepting an Esquimaux Indian's, in which smoke is not considered an intolerable nuisance, an atmosphere unfitted for living and breathing in? Let the author and his readers take the word of one who, like most Europeans, from early custom, long preferred the brightly blazing, yet sulphurous and smoke-producing bituminous coal, to the non-blazing, yet cleanly and economical anthracite: let him and them be assured, that, with the familiar modes, the ready appliances, and the improved methods, now in universal use in the Atlantic cities of America, there cannot be a reasonable apology for hesitating as to the choice of the two combustibles for domestic use. The difficulty suggested about ignition, even were it found so in practice, is deprived of all weight from the consideration, that with ordinary attention, a fire, when once kindled in the fall of the year, may be kept up until the return of summer, if needed. The supposed tendency of anthracite to emit a greater amount of noxious vapours during combustion than bituminous coal, is contradicted by the daily experience of those who employ the former in their apartments, and is much less objectionable, on that head, than bituminous coal.

Our tables of analysis at the end of this volume, will, if doubts remain, decide this matter. In fact, they show that the anthracites contain less sulphur than the blazing coal; the consequence of that obnoxious substance having almost entirely been expelled, during the conversion from bituminous coal into anthracite. The following analyses are from the Report of Prof. H. D. Rogers, in relation to Pennsylvania coals of each description:

	BITUMINOUS COALS. Sulphur per cent.	ANTHRACITES. Sulphur per cent.
The Karthaus Coal,	2.70	
Blairsville Coal,	2.60	
Lehigh Anthracite,		0.91
Pottsville, White Ash do.		0.60
Do. Red Ash,		0.48

We have neither soot in the chimneys, nor smoke in the atmosphere.

AREA OF ANTHRACITE FORMATIONS IN PENNSYLVANIA.

The original estimate of the superficial area of the three anthracite regions in Mr. Packer's report, was nine hundred and seventy-five square miles, or six hundred and twenty-four thousand acres.* It is customary for every writer on Pennsylvania statistics or topography, to adopt these admeasurements. Professor Rogers, however, reduces this computation materially, and offers two hundred square miles—one hundred and twenty-eight thousand acres, as the approximate area.† This result presents such a contrast with former estimates, that were we not familiar with the general accuracy of that gentleman's estimates, we might suspect some error, unless the calculation be limited to the two southerly regions, as is probable.

A different result has been published by Mr. S. B. Fisher, a district surveyor, long engaged in the anthracite regions.‡

		Sq. Miles.	*Acres.*
I.	The Southern or Schuylkill coal-field, workable coal measures, exclusive of the external margin of conglomerate, 67,500 acres+8,450 acres on Broad Mountain,	119	75,950
II.	The Middle Coal District, comprising several basins, stretching from Shamokin to the Lehigh, over Broad Mountain, but exclusive of some of the small basins north of Hazleton. Mahanoy coal-field, 59,450a+the small basins 26,075,	133	85,525
III.	Wilkesbarre or Wyoming, or Northern Coal District—estimated by H. Colt,	120	76,805
	Total, with the foregoing exceptions,	372	238,280

Our own computation, although by no means exact, as even now the boundaries are not generally determined, is as follows:

		Sq. Miles.	*Acres.*
I.	The Southern or Schuylkill coal region, consisting of three principal basins, viz. 1. The great southern basin; 2. The basin north of Mine Hill; 3. The basin south of the Mahanoy creek,	164	104,960
II.	The Mahanoy and Shamokin, principal basins, including several minor basins or troughs,	75	48,000
	the eastern group of basins, at least twenty-six in number,	40	25,600
III.	The Wyoming coal-field in one area, but broken into several subordinate undulations or basins,	118	75,520
		397	254,080

To render our exposition of the Pennsylvania group of anthracite basins

* Report to the Senate, 1834, p. 438.
† H. D. Rogers in Trans. Assoc. American Geologists, Vol. I. p. 436.
‡ Miners' Journal of Pottsville, March 29th, 1841.

more complete, we have prepared the map hereto annexed. It will be seen that, although in a few details, hereafter to be supplied, something might still be amended, yet our draft is greatly superior in topographical minutia, in geological features and physical characteristics, to any other which has heretofore been published. We should have been happy to have had a precedent to follow, in a State geological map, but, as none yet exists, we have been thrown on our own exertions and resources to produce the present one.

I. THE SCHUYLKILL COAL REGION OR SOUTHERN DIVISION AND GROUP OF ANTHRACITE BASINS.

So many reports have been published relating to the property of individual coal companies, and to the general interests and characters of this district, that we cannot undertake even to enumerate them. On the more prominent of these, however, we shall bestow some cursory notices.

Without designing any injustice towards other regions, it may be expected, in the present instance, that we exercise somewhat less of brevity; seeing that for some years it has occupied an extremely prominent position in the mineral statistics of Pennsylvania. It appears entitled to this consideration at our hands, inasmuch as it lies the nearest to the ports, or places of shipment; it has employed the greatest amount of active capital; has been the most extensively worked, and the most assiduously investigated; and, moreover, has called into exercise the largest quantum of practical and scientific intelligence ever concentrated in one mineral area on the American continent.

Among the earliest original describers we may mention Professor Silliman, who, in his Journal of December, 1830, called attention to the extraordinary development of anthracite at Mauch Chunk.

We have already adverted to the excellent report by the chairman of the Pennsylvania Coal Committee, in 1834. One section of this report especially relates to the Schuylkill coal-field, as then understood, and to its mining statistics, up to that period. The summary of these details, for the year 1833, is as follows:

Coal mined and sent to market,	429,933 tons.
Capital invested,	$5,022,780*

To this special report succeeded many temporary as well as annual reports of coal companies, to which we cannot advert in detail; and many incidental statements quickly followed, in connection with railroads, canals, public improvements, and private enterprise.

Most of these were illustrated by maps, sections, and other instructive diagrams, appertaining to the country in question. Some are on an extensive scale, and embody a large mass of information. In fact, it may be stated that few coal districts in the world have received more ample illustration, within a similar period, than has the Schuylkill coal-field, from the united exertions of the topographer and the geologist, the chemist, the operative miner, the engineer, the artist, the economist, and a variety of subordinate contributors and fellow-labourers.

As a state undertaking, the annual reports of the geologist, on the progress of his survey, have a primary claim to consideration and commendation. We await, with confidence, the final report, which will complete our

* Packer's Report, p. 458.

knowledge of this interesting country, and of the results of many years of indefatigable research.

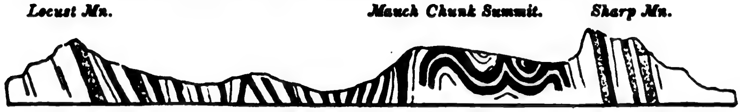
It is only by an elaborate survey, such as that ordered by the state—for we can scarcely contemplate a private undertaking of this magnitude—that we shall be led to a right understanding of this subject, and receive enlightenment on phenomena so irreconcilable with those displayed elsewhere.

We are greatly in need of detailed maps of all the anthracite basins.

SKETCH OF THE SCHUYLKILL OR SOUTHERN COAL-FIELD—COMMENCING EAST.

Fig. 6.

Section of the Mauch Chunk Anthracite Region, looking East.

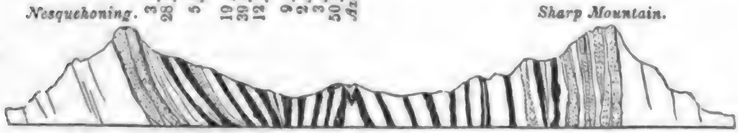


The remarkable exposition of an enormous mass of anthracite, which was quarried to open day on the summit of the Mauch Chunk Mountain, near the eastern termination of this coal-field, excited, for a time, no small attention, not only in the United States, but in Europe.* We have already cited some historical notices attending this discovery, and the difficulties originally encountered in rendering it available. The great bed on the summit at Mauch Chunk is estimated to be from fifty-five to sixty feet thick, including the inferior seams, and also some shale beds. The open quarry here is more than thirty acres in area of excavation: in fact, there are now several of these open workings. At the neighbouring coal works of Room Run, the main bed is found to be fifty feet thick, resting, as at Mauch Chunk, upon a thick bed of under-clay, filled with stigmaria. From these two working points, have been abstracted and sent to the markets of Philadelphia, New York and Boston, about three millions of tons of anthracite.

NESQUEHONING OR ROOM RUN SECTION.

Fig. 7.

Section at Nesquehoning, or Room Run, looking East.



aa Red Shale and Red Sandstone. Course N. 65° E.
bb Conglomerate.
cc Coal Measures.
d Anticlinal Axis or Saddle.

The remarkable thickness of the coal at the summit appears to be the result of the doubling back of the twenty-eight feet seam upon itself, making an aggregate thickness of fifty-six feet.

* Silliman's American Journal of Science, 1830.

There are about twelve coal seams on either side of the axis forming this basin; eight of these were in work in 1847, and had an aggregate thickness of one hundred and sixty-three feet of anthracite, of which a fair proportion consisted of merchantable coal. These were all south-dipping seams; those on the corresponding or opposite side of the axis, apparently contained at least an equal amount of good coal, probably the repetition of the same veins.

It is by no means easy to convey a true representation of the position of the coal beds on the summit at Mauch Chunk, owing to the numerous contortions of that part of the general basin. The extensive works recently put in operation, will go far to develope the intricacies of this singular district. The further advance of these undertakings in regard to production, will be detailed in a subsequent page. At present, we must make a hasty travel from end to end of this basin; stopping, for a brief space, at a few prominent points on the way.

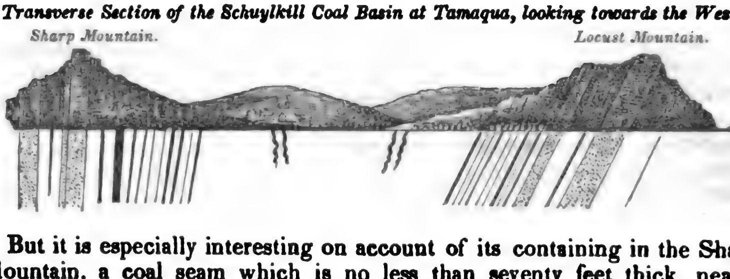
Leaving Mauch Chunk and the Room Run mines, which have acquired some celebrity through the notices of travellers, geologists, and men of science,* and produced in 1837, 334,929 tons, the next important position is that of Tamaqua.

TAMAQUA.

The section we here introduce, represents the arrangement of the coal seams on each side of the valley or synclinal axis; those on the Sharp Mountain or south side, being nearly vertical.

Fig. 8.

Transverse Section of the Schuylkill Coal Basin at Tamaqua, looking towards the West.



But it is especially interesting on account of its containing in the Sharp Mountain, a coal seam which is no less than seventy feet thick, nearly vertical. This valuable coal area was illustrated, in 1835, by an article in the Transactions of the Geological Society of Philadelphia, accompanied by a "petrographical map and section," by Mr. Koehler.† These illustrations exhibit a transverse section of the entire coal-field at that place, and the position of thirty-two workable coal seams, of three feet thick and upwards. It does not appear to have been suspected at the time, by the author, that this number represented duplicated seams, arranged in synclinal form; and that, consequently, the true number represented was not more than the one half of his supposed series, which embraced a total thickness of many feet of coal, the largest seam then known, being twenty-eight feet. The anthracite of Tamaqua is less indurated than that near the Lehigh. An investigation into the nature of this coal and its ashes had been previously instituted by Professors Bache and Rogers.‡

* Journal Academy Natural Sciences, Philadelphia, Vol. V. p. 17. Experiments on anthracite by L. Vanuxem.

† Trans. Geol. Soc. of Pennsylvania, Vol. I. p. 326.

‡ Ibid. Experiments on the ashes of anthracite, Vol. VII. p. 158–162.

Passing by Tuscarora, and by several mining villages that have sprung up within a few years, we reach Pottsville and a circle of colliery establishments in its vicinity; the focus wherein is concentrated an enormous amount of productive and manufacturing industry, such as has few parallels in the new world; considering the short period since the origin and development of its resources. The magnitude of the mining business of the Pottsville district will appear from the tables which we shall furnish in another place.

Numberless are the documents, reports, maps, and statistical statements, published and unpublished, that have contributed to give celebrity to this district. A transverse section of this coal-field, in the meridian of Pottsville, has been for some years in every body's hands. It appears to have resulted from the combined observation of many local explorers, practical operators, and mining engineers and surveyors. The same mistake was made here, as we have mentioned at Tamaqua, in reference to the repetition of beds by means of undulations in the strata, and by the recurrence of several alternate axes of elevation and depression. In 1836, the supposed consecutive series of coal seams numbered in Mr. Wilde's section, seventy-eight, which had an aggregate thickness of four hundred and fifty-four feet of coal. Several years afterwards, this number had been increased to one hundred and eight, and the total thickness was augmented in the like proportion.

Of late years, the accuracy of opinions so confidently expressed by merely operative persons, without the intervention of geological investigation, gradually began to be doubted, by those geologists who had acquired experience in unravelling the intricacies of districts of complicated structure, and in studying, on an extended scale, the effects produced by disturbing agencies of great power. We are unable to say, with precision, with whom these new and correct views originated. Like most subjects of this nature, they were, doubtless, the result of gradual development, as facts and illustrations accumulated. Even now, many details have to be collected, ere all the phenomena of this district, the *bouleversements* of its mineral beds, and the repetition of its groups, shall be thoroughly elucidated.

Our own views, in this matter, entirely coincide with those of the State geologist, and we perceive also, that Mr. Logan, provincial geologist of the Canadas, who has examined the Schuylkill coal-field, adopts similar opinions. All recent investigations tend to confirm these conclusions, and to show that the series of coal seams in the Pottsville section, which were formerly considered to be so numerous, and to embrace an astounding thickness of anthracite, ought to be reduced to one fifth, in certain localities, on account of the repeated flexures within the general coal area, which occasion many recurrences of the same seams.*

The necessity for revising all the old statements which may be found, regarding the local topography of the anthracite country, and which have been transferred into works of standard repute, both in America, and in Europe, will appear from a very few examples; but, at the same time, owing to the remarkable subdivision of the groups, it becomes no easy task.

A description of the mines of the southern coal region was officially published some years ago; wherein it was stated that there were at the Room Run mines fifteen beds of anthracite, whose aggregate thickness was two hundred and forty-two feet. Like most of the early reports, which were

*** Proceedings Geol. Soc. of London, Vol. III., "On the coal-fields of Pennsylvania," by M. E. Logan, March, 1842, p. 707. The author adverts to the stigmaria beds in this field, associated with the coal, and by them he was enabled to detect the inverted position of the strata.**

generally made by unscientific persons, this contained glaring errors and exaggerations; by reason of counting the same seams two, three, or more times over. Another report, from the same quarter, announced the total thickness of coal in nine proved beds, on the north side of the basin only, at one hundred and eleven feet, and ninety feet on the south side; being two hundred and one feet in the aggregate.* This is no otherwise incorrect than as relates to the doubling of the series.

At the commencement of operations at Beaver Meadow, in 1836, the present writer was informed by the engineer, Mr. Wilde, that he had proved three hundred feet of coal there, but it appears to be admitted, now, that about forty feet constitute the principal working series, in that quarter.

A report to the legislature of Pennsylvania, by a committee appointed to examine the Swatara coal mining district, in 1839, announced the presence of seventy veins there, of from three to more than twenty feet in thickness each, then known, and many others were supposed to remain undiscovered.† No accurate transverse section has yet been made, across the field, in the meridian of Pinegrove; but from what we already know of that region, it is probable that at least eight repetitions of the same series of coal seams occur there, and the number of actual and distinct seams is, consequently, lowered to a comparative few.

We shall quit this branch of our subject, for the present; merely observing, by the way, that a clear insight into the actual arrangement of the coal-fields, respectively, can only be completed after the construction of more authentic maps, sections, and diagrams, and by more actual admeasurements, for the purpose of geological elucidation, than are now at hand. A very large and, apparently, very valuable portion of the aggregate area, remains, still, in nearly its original obscurity.

The local maps, which have been issued in a coarse and cheap form, for the temporary requirements of parties having local interests, are somewhat numerous; but they have very little scientific merit or artistical pretension. Illustrations of a far superior character to these are now called for; and the augmented value of mineral property here, would render the cost of such a work, a comparatively light burden upon the owners.

CAPITAL EMPLOYED IN ITS PRODUCTION.

The Statistical Return to Congress, in 1840, exhibits the amount of anthracite raised, - - -	859,686 tons.
of men employed in mining it, -	2,977
of capital invested, - - -	$4,334,102

Like most other returns on this branch of industry, made at this period, this is evidently below the mark. It was shown, in 1839, that in the Schuylkill mining district alone, capital to the amount of $10,360,555 was invested.‡

As far back as the year 1833, when the coal trade was, comparatively, in its infancy, the capital invested in the production of anthracite, and in the means of transportation, in canals and railroads, in the purchase of coal lands, and in working capital, was $19,176,217.§

* Report of the Lehigh Company, January, 1844, p. 24.
† Report to the Legislature, by H. K. Strong, 1839, p. 29.
‡ Report to the Legislature of Pennsylvania, on the Swatara Mining District, 1839.
§ Report to the Legislature of Pennsylvania, on the subject of the Coal Trade, 1834.

This calculation does not include the value of store-houses, wharves, landings, &c., in Philadelphia, New York, Boston, and other places; or the value of the vessels and the capital employed in shipping this coal.

In 1839, a statement, emanating from some persons well acquainted with the business affairs of this neighbourhood, showed that the capital engaged in mining and transporting anthracite; including the lateral railroads, engines, cars, wagons, boats, land and houses, amounted to the sum of $7,394,375.*

In 1842, at a public meeting of persons engaged in the coal trade, in Schuylkill county, 31st January, a report on the coal statistics of that county was made; by which it appears that the capital invested under the foregoing heads, with the addition of the Reading railroad, the Danville and Pottsville railroad, and the Schuylkill navigation, amounted to $17,526,000.

Population engaged in, or entirely dependent on the coal trade, - - - - - -		17,000 persons.
Number of horses employed in boating, and at the collieries, - - - - - -		2,100 horses.
Agricultural products annually consumed,	$588,572	
Merchandize consumed, - -	$918,325	
		$1,506,897

These statements are understood to comprehend only the coal production of the county of Schuylkill.

At that time, there were in use, in this county, thirty steam engines, amounting to upwards of 800 horse power: 22 of these engines were manufactured there. 850 canal boats, 2100 horses, 145 miles of railroads, and 3900 railroad and drift cars, were in full employ: and all this had originated within about fifteen years.†

In 1846, the number of steam engines employed in the collieries of Schuylkill county alone was 68, having an aggregate horse power of 2018; in addition there were constructed 38 others, having a power of 903 horses: in all 106 engines and 2921 horse power.‡

M. Chevalier, who investigated the canals, railroads, and resources of the United States, in 1839, remarks of Pennsylvania,—after describing the extent of her canals and railroads, both public and private,—projected and completed,—that such a result would be very remarkable on the part of an ancient people, who had, for a long period, applied themselves to the perfecting of their communications. It appears prodigious, when one remembers, that all these works, with only one or two exceptions, were not commenced,—were not even projected, in 1825.

"Il faut faire un effort pour concevoir comment un population aussi restrainte que celle de la Pennsylvanie, a pu entreprendre, et achever à peu près, un pareille masse de travaux dans un délai aussi court."§

* Miners' Journal of Pottsville, January 5, 1839.

† Miners' Journal of Pottsville, January 1, and February 5, 1842.

‡ An. Rep. Board of Trade, April, 1847.

§ Historie et description des voies de communication aux Etats-Unis, tome premier, p. 542.

I. SCHUYLKILL COAL REGION.

CENTRAL AND WESTERN DIVISIONS OF THE SOUTHERN BASIN, OR GROUP OF COAL BEDS, EMBRACING SCHUYLKILL COUNTY.

The annual returns of coal production from the different coal-fields are becoming more difficult of classification, every year, and must of necessity be abandoned for a more general system, especially as relates to the districts usually known as the southern and middle coal-fields. As these regions become blended together by a net work of railroads, the original distinctions become obsolete, or are lost. Already, for instance, some of the coal of the Wyoming or northern region descends the Lehigh, and swells the returns made from that channel, which already receives the coal of half a dozen other basins.

So also the Pinegrove region sends part of her coal by the Union canal, and part by the Reading railroad or the Schuylkill navigation; thus affecting the results of the yearly returns. In like manner, the anthracite of the middle region will reach market by various routes, and be blended with the contributions of all the other districts.

Annual Production of anthracite sent, by canals and railroads, to market from the mines, exclusive of the coal consumed upon the spot, or in the vicinity, from the commencement. This return from Schuylkill county necessarily embraces also that part of it, which is known as the Swatara or Pinegrove district, and also the Little Schuylkill district.

We have adopted the statistical returns of the Miners' Journal, with the exception of a few corrections from official reports of companies.

Years.	Tons.	Years.	Tons.	Years.	Tons.
1825	6,500	1833	252,971	1841	602,345
1826	16,767	1834	233,603	1842	573,273
1827	31,360	1835	353,399	1843	700,200
1828	47,284	1836	443,755	1844	874,850
1829	79,973	1837	539,734	1845	1,131,724
1830	89,984	1838	446,875	1846	1,295,928
1831	81,854	1839	465,247	1847	1,583,374
1832	209,271	1840	476,151		

Total, - - - 10,536,422

The Miners' Journal of Pottsville makes the amount, 10,213,120

The production of anthracite from the *eastern or Lehigh division* of the southern basins, and central group of coal beds, will be separately arranged under the returns from the Lehigh district, in a succeeding page. The return for 1847 was 643,973 tons, and the aggregate, since the opening of the trade to the 1st January, 1848, is 4,360,108 tons.

The foregoing table embraces the Little Schuylkill or Tamaqua coal district, having its outlet at Port Clinton, which, in 1847, produced 106,401 tons, and altogether from the opening of the district, in 1832 to 1847, inclusive, furnished 664,657 tons, as its quota. The arrangements, in progress at this establishment, will ensure a vastly accelerated supply, in future.

We have stated that the Schuylkill coal-field supplied three species of anthracite. The environs of Pottsville furnish two of these; and we are indebted to the editor of the Miners' Journal, of that place, for a statement

of the relative proportions of each kind, that were sent from thence, in the year 1846.

		Including Pinegrove.
White ash coal,	703,000 tons.	703,000 tons.
Red ash coal,	539,000 "	592,928 "
	1,242,000 "	*1,295,928 "

The Journal last named informs us that the number of colliery establishments in Schuylkill county, in 1846, was 142, including ten in the Swatara region: of these 35 collieries are below the water level, viz. they are drained by steam power. There were, further, 22 collieries in preparation, of which ten are below the water level.

During the agitation of the tariff, in 1846, at Washington, it was stated by Mr. Cameron, of Pennsylvania, that thirty years ago, coal was entirely unknown in this country; yet, in 1846, it gave employment to five millions of days' work, annually. It kept in movement a thousand ships of a hundred and fifty tons each, and afforded a nursery for the training of six thousand seamen, who earned three millions of dollars yearly. It gave circulation to a capital of fifty millions of dollars. It kept in activity fifteen thousand miners, and sustained a mining population of seventy thousand souls, who annually consumed upwards of two millions worth of agricultural productions, and more than three and a half millions of dollars worth of merchandize.

DECREASE OF THE NUMBER OF OPERATIVES IN THE SCHUYLKILL COAL REGION.

We observe, in a late statistical report of this district,† some details, which appear to be deserving of a passing notice. "There were only one hundred operators engaged in mining coal, in the whole Schuylkill region, during 1847. As the expenses of mining increase, the number of operators are gradually diminishing. This is apparent from the fact, that, although the number of *collieries* have increased during the last year, the number of *operators* in the region have diminished, down to about one hundred. Three years ago, they numbered about one hundred and forty. Some of the larger operators now work five or six collieries."

The Schuylkill collieries are, (Jan. 1, 1848,) situated as follows:

Above water level, - -	101
Below " " - -	42
Total, - -	143

Price of Labour in the Coal district of Pottsville.

Periods.	Wages per day.		Observations.
	Miners.	Laborers.	
1831	$1.00	.82	The tariff of 1828 on coal and iron, in full force.
1840	1.00	.80	The reduced tariff in operation. Wages paid in goods, making a difference of 15 to 20 per cent. against the labourer.
1842	87½	.70	Paid in traffic—one half the labourers had no employment.
1844	1.10	.76	The tariff of 1842 took full effect; all were employed, and labour was in demand.
1845	1.13	.80	Business continued as in the previous year.
1846 } 1847 }	1.25	.83	Business improving in activity; all wages paid in money, as has been the case for four years.

* Miners' Journal, January 30, 1847. † Pottsville Miners' Journal, January, 1848.

The details of the foregoing table were arranged, from the books of one of the most important coal companies in the United States, with a view to show that there had been an advance in the price of labour in the mineral districts of Pennsylvania, under the influence of the tariff of 1842; a state of things which had been assumed, somewhat theoretically, to be unfounded.*

We have ventured, towards the commencement of this volume, to suggest, for reasons assigned, that the imposition of duties on imported bituminous coal has had, and will continue to have, very little influence on the prices of anthracite.

Table of Prices of Anthracite in Philadelphia, New York, and Boston, in the following years.†

Years.	Philadelphia. Wholesale, per ton of 2240 lbs	New York. Retail, per ton of 2000 lbs.	Boston. Retail, per ton of 2000 lbs.
1839	$5.50	$8.00	$9.00 to 10.00
1840	5.50	8.00	9.00 to 11.00
1841	5.00	7.75	8.00 to 9.00
1842	4.25	6.50	6.00 to 6.50
1843	3.50	5.75	6.00 to 6.50
1844	3.37	5.50	6.00 to 6.50
1845	3.50	5.75	6.00 to 7.00
1846	4.00	6.00	6.50 to 7.00
1847	3.85 to 4.00	5.50 to 6.00	6.50 to 7.00

In 1840, mining labour was $5.00 to $7.00 per week; in 1846, $8.00 to $10.00 per week.‡

SWATARA AND PINEGROVE DIVISION OF THE SCHUYLKILL REGION.

Having its outlet by the Union Canal.

Proceeding westward, after leaving the Schuylkill river, we arrive at the *Swatara Coal District*, which in 1839, and nearly for the first time, was investigated by direction of the legislature.§ Although possessing a great number of very excellent coal seams, the business enterprise has heretofore greatly languished, on account of difficulties, both local and temporary, in this quarter; especially those arising from inadequate facilities of transportation. Many of these disadvantages are already overcome, and the rest will vanish in proportion as the near prospect of profitable remuneration awakens the energy of the proprietors and adventurers.

Many associations for coal mining, canal or railroad purposes, have here invested capital, and these are already busily occupied in carrying out their respective undertakings.

We insert the following statement of the quantity of anthracite which was sent down from the Pinegrove or Swatara district, by the Union Canal and Feeder, according to the annual reports of that company. We will observe that the first communication between the Swatara coal region and

* Pottsville Miners' Journal, June, 1846, and subsequently.
† Report of the Board of Trade of Schuylkill county, April, 1846, and subsequently.
‡ Speech of Mr. Cameron, in Congress, July 22, 1846.
§ Report to the Legislature of Pennsylvania on the Swatara Mining District, 1839, p. 29.

the Union Canal, was effected in 1833. In 1847, a railroad being completed from the district around the head waters of the Swatara and the Reading railroad, 42,145 tons of anthracite were conveyed hence to market at Philadelphia, by the Schuylkill route, in addition to 67,437 tons via the Union Canal.

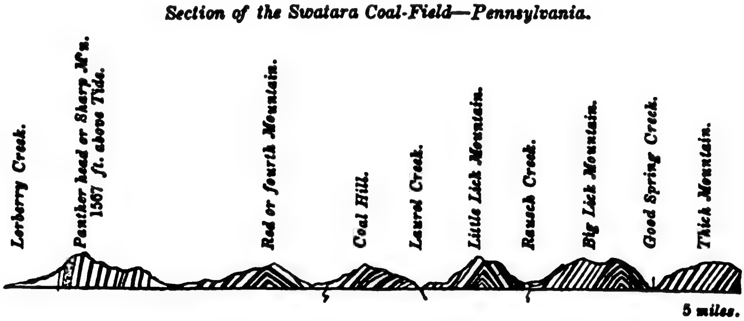
Years.	Tons.	Years.	Tons.	The details of bituminous coal in these columns are derived from the annual reports of the Managers; the years ending 1st Nov. and the tons consisting of 2240 lbs. each, or of 28 bushels.
1834	6,911	1841	17,653	
1835	13,891	1842	32,381	
1836	11,710	1843	22,905	
1837	16,550	1844	34,916	
1838	13,000	1845	47,928	
1839	20,639	1846	55,504	
1840	23,860	1847	62,549	
Conveyed by the U. Canal,		Total,	297,696	

Within the area drained by the Swatara river and its tributaries, the main coal-field separates into two forks, one striking towards the north-west, the other directed towards the south-west, and stretching almost to the Susquehanna. The north fork, which is a double basin, is eighteen miles in length, and the southern one, which is a single basin, is thirty miles; and, at the termination of the former, they are more than ten miles apart.

The entire breadth of the Swatara region is occupied by a series of anticlinal and synclinal axes, by means of which the numerous coal seams are repeatedly brought to the surface; exhibiting, in the aggregate, indications of a vast amount of anthracite.

Fig. 9.

Section of the Swatara Coal-Field—Pennsylvania.



Heretofore, the wild and broken character of the surface has opposed difficulties to the complete geological development of the numerous highly inclined strata. It is only by means of the gradual progress of local improvement,—of the operative mining industry of the country, and of a more correct system of surveys,—that we shall acquire a thorough insight into the structure of this region.

The committee on the Swatara district, in 1839, were compelled, from the difficulty of the task, to abandon all expectation of obtaining a list of the coal seams. They stated, however, that about forty beds, of from three tp more than twenty feet in thickness, had then been opened. The lowest number of seams in a condition to be worked, they estimated at seventy,

without passing into the north or Broad Mountain. We know well, at the present day, the erroneous nature of this view, and that what was then taken to be one general series or continuous group, was, in fact, a series of repetitions of a much smaller number, as we have already suggested.

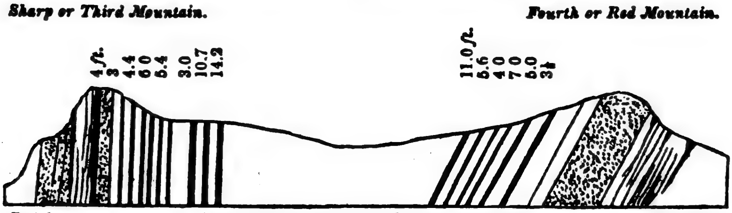
From the very remarkable physical characters of the Swatara region, at the point or pivot from whence diverge the two forks, of which we have spoken, it would be but reasonable to expect an unusual extent of disturbance, through the crushing influence of a movement so stupendous as we perceive must have there taken place. We could scarcely fail to suspect the prevalence of such phenomena as frequent lines of dislocation and cross fracture; and, accordingly, we perceive abundant evidence of the fact, in the numerous transverse ravines, of great depth, at right angles to the strike of the strata, and now forming so many outlets or channels for the drainage of the interior area. The thirty-six breaks or gaps, which in 1839 were viewed as particularly advantageous circumstances, favorable to the mining economy of the district, we are led to believe, mark, with unerring exactness, the sites of original fissures or fractures, crossing perpendicularly the longitudinal axes of the coal measures. Whether, as has been suggested, there has been any lateral movement or heaves, to disturb the linear continuity of the strata, we are at present unaware. Hitherto we have perceived no evidence of such a tendency; we are only surprised to observe so little interruption to the general range of the coal beds.

DAUPHIN COUNTY COAL DISTRICTS.

The North-west, or Bear Valley Fork, in Schuylkill and Dauphin counties, will, at some future period, be the theatre of very extensive mining operations. It contains a numerous suite of coal seams, two or three times repeated; some of these are of great power, and all of them are of excellent quality, especially adapted to domestic use. They are of the white or grey ash variety of anthracite, but of easy combustion; while those at the southern side of the region, towards the Sharp mountain, consist of the red-ash and free burning kinds; a description which is highly esteemed for domestic fuel, but not so efficient for the iron furnace. An investigation of the western extremity of this district, in the fall of 1846, has been the subject of an elaborate report by the present writer, addressed to the Lyken's Valley Coal Company.* About 60,000 tons of coal were mined here within the last ten or twelve years.

Fig. 10.

Section at Black Spring Gap, Lebanon county, looking West.



Scale 1600 feet to an inch, both vertical and horizontal.

* Report to the Lyken's Valley Coal Company, by R. C. Taylor, 16th Dec. 1846.

The South-west Fork terminates, acutely, within two miles of the Susquehanna river, and formed the subject of two very detailed reports, in 1840, by the present writer.*

After passing Fishing Creek Gap, and entering Lebanon county, at Black Spring Gap, fourteen beds of coal, viz. eight on the south side and six on the north side of the axis, were proved; whose aggregate thickness of free-burning red ash coal, was ninety-one feet. At Rausch Gap, nine southern seams were proved. In number and volume the series then decreases, as we proceed through Dauphin county, and the mountain contracts in breadth, until, at eight miles from the Susquehanna, it presents a very slight prospect of advantageous working, further to westward. Finally, it contracts into a narrow insignificant ridge, terminating entirely before reaching the Susquehanna river.

CHANGE OF CHARACTER IN THE COAL OF THE SOUTH-WEST FORK.

It is within this small district, along a distance of more than ten miles, that the coal parts with a portion of its anthracite character, and assumes that of a semi-bituminous, dry, and blazing coal; resembling the steam coal of South Wales, and having a slight tendency to adhere or cake. It possesses properties which eminently entitle it to the reputation it has already acquired, as a valuable species of fuel; the more remarkable as occurring in an anthracite region, and as being part of the same beds which consist of compact, pure anthracite, as we advance towards the Lehigh.† The gradations and modifications of this semi-bituminous Stony Creek coal, adapt it for a variety of purposes, and a selection of any required quality can here be made. Our table of Assays, in another part of this volume, shows this transition with great distinctness.

Among the early notices of the passage from the purest known anthracite to a species which is not only less dense and ponderous, but contains a gradually increasing portion of volatile matter, we find that of Mr. Packer's Report, in 1834, who adverted to the already well-known change in the condition and character of the Schuylkill coal, when traced from the eastern to the western extremities of the region. His remark, in substance, is, that "extending westward the coal becomes somewhat lighter; the specific gravity of the Mauch Chunk coal being 1.494; the Schuylkill, in the vicinity of Pottsville, 1.453; and the Pine Grove, Wiconisco and Stony Creek, about 1.400. The latter is somewhat more inflammable and easy of ignition, or, to use a prevailing idea, 'partakes more of the bituminous character.'"

This bituminous character of the last mentioned coal had been investigated, some time previously, by Professor Renwick, and was especially adverted to by him in a printed circular, in 1832; also, by Prof. W. R. Johnson, in his letter, dated April, 1838, to the National Foundry Committee.

CHANGES AND VARIATIONS IN THE MINERAL CHARACTER OF COAL SEAMS.

In an appendix to the Stony Creek Report, already alluded to, the writer, who was familiar during twenty-five years preceding with precisely similar phenomena in the basin of South Wales, endeavoured to illustrate these pa-

* Reports on the Mineral Lands of the Stony Creek Estate, and those of the Dauphin Coal Company, by R. C. Taylor, President of the Board of Directors, 1840.

† Report, Tables iii., ix., x., xi., xii., and xix.

rallel cases by a series of analyses both of American and European varieties of coal. These details were derived from well known authorities. Following up the plan, we have prepared a table of at least eleven hundred analyses of coals in all parts of the world, as a fitting and elaborate illustration of the present work. These tables will be found at the end of this volume. The authorities cited are the following:

In Europe.—Mushet, Ure, Dufrenoy, Berthier, Thomson, Schafhæutl, Robin, Karsten, Ffyfe, Richter, Kirwan, Richardson, Murchison, Lyell, Varin, Baudin, Piot, Elie de Beaumont, Flachat, Logan, Liebig, Pelouze, Regnault.

In America.—Troost, Ducatel, Jackson, Hayes, Clemson, Ellet, Johnson, Frazer, Shepard, Olmsted, Bache, Silliman, Rogers, Booth, Lea, Renwick, Chilton, Boyé.

To all these we must especially add the highly comprehensive and instructive memoir of Prof. H. D. Rogers, in the Transactions of the Association of American Geologists, on the Appalachian Coal Fields. This paper is a rich contribution to American geology; and it is due to the writer thereof to state that his views on the subject on the transition from anthracite to bituminous coal had been stated through the medium of his public lectures, in 1837, and were more fully developed in 1843.

For local statistics we have frequent acknowledgments to make to the newspaper press, among which we are bound to name the Miners' Journal, and the Anthracite Gazette, of Pottsville; the Mining Journal, of New York; and the Commercial List and other leading journals of Philadelphia. From such prolific sources as Hunt's Merchant's Magazine, Hazard's Register, the American Almanac, &c., we have been permitted to glean many valuable details. To proceed:—

That changes in the composition of the coal, from a partially bituminous state to that of anthracite, occur in other parts of the world, several instances will be found in these pages. Those of South Wales and of the Donetz coal-field in Russia, and on a smaller scale in several of the basins of France, are cases in point.

In like manner the flaming coals of the Auvergne and Bourbonnois basins, are shown to contain a complete series of dry coals with a short flame; of fat coals with short flame; of fat with long flame; and dry with long flame. Also, in the basin of Commentry, we find, at some hundred metres of distance, and upon the same margin of that basin, the anthracite of Chambled, and the dry coal with long flame of Ferrières.*

The Schuylkill coal region possesses striking points of resemblance, although upon a somewhat different scale, to the great coal basin of South Wales. The latter is ninety-four miles long, and averages about fifteen miles in breadth. Of this elongated area, the western seventy-four miles consist of anthracite beds, with the exception of some partly bituminous seams on the south side of the basin. The remaining twenty miles, on the east, consist of dry bituminous coals, semi-bituminous coals, and steam coals; but, occasionally, the same section yields beds of coal of modifications of all these varieties.

The Schuylkill region is sixty-five miles long; extremely attenuated for eight or ten miles, at its western extremity, so as to be unproductive there to any important amount. For about eighteen miles out of the sixty-five, at its western prolongation, the quality of coal is of an intermediate character, like the steam coal of Wales. It then gradually passes to free burn-

* Annales des Mines, Vol. I., 1842, p. 96.

ing anthracite on entering Schuylkill county, from Lebanon; and, still further east, to the hardest and purest anthracite. We have, elsewhere, pointed out a similar passage from the extremes of each quality, like those in Russia, and we add that of the coal basin of St. Gervais, in Hèrault, France.

GEOLOGICAL MODELS.

In intimate connection with the physical and economic geology of the Schuylkill coal region, the author may be here permitted to advert to a species of illustration, for the first time introduced in America, by himself. In 1840, a geological model was constructed of the western half of the Schuylkill coal district and its vicinity, upon a scale of two inches to the mile. The area so represented comprises seven hundred and twenty-three square miles, or 460,800 acres, being in breadth sixteen miles and in length forty-five miles. This model was first exhibited to the Association of American geologists and naturalists, at their meeting in Philadelphia, in April, 1841, to illustrate an address "on the most appropriate modes of representing geological phenomena."*

Dr. C. T. Jackson, in his first general report of New Hampshire, in 1841, also takes occasion to recommend, strongly, the process of geological illustration through the aid of models. He, however, states his regret at the expensive nature of such works, and the length of time requisite for their completion.†

II. MIDDLE ANTHRACITE DISTRICT.

FIRST SUBDIVISION. THE SHAMOKIN COAL-FIELD.

In proportion to its magnitude, this is the richest and most regular of all the Pennsylvania basins. The coal seams are unusually abundant. The writer ascertained the out-crops of upwards of twenty, towards the centre of the basin, in 1847, and more remain to be developed. Some of these are of large size, one being twenty-seven feet; and one, much larger, is called the Big or "Mammoth Vein." Its maximum thickness is said to be here about fifty feet.

* Silliman's American Journal of Science, vol. xli., p. 81, 1841. Also, Transactions of the Association of American Geologists and Naturalists, vol. i., p. 81.

† Report of New Hampshire, by Dr. C. T. Jackson, 1841, p. 36.

NOTE.—In Europe, geological models and models exhibiting lines of railroads, mines and harbors, and even estates, are much coming into use; although the frequency of employing so desirable a mode of representation is impeded by the heavy cost of such works. This objection applies with even stronger force in the United States, where capital is less abundant and where economy is indispensable.

We perceive by a paper read to the Institution of Civil Engineers, in London, "on the construction of geological models," by Mr. J. B. Denton, May, 1842, that the cost was stated at from 2s. 6d. to 3s. 6d. = $0.60 to 75 cents, per *acre*. Of course the expense is influenced by the scale on which the mode is projected. As Mr. Taylor's model of the Schuylkill region contains 460,800 acres, it would amount to a considerable sum, even at one fiftieth part of the above named prices.

Again, the author referred to states that a model, showing the line of a railroad or canal, would cost ten pounds [£10,] per mile. There are about one hundred and seventy miles of canals and lines of railroads and projected railroads shown on Mr. Taylor's model. If these rates include all the preliminary expenses of surveys and the collection of details, they are perhaps not so greatly overrated.

Since writing the foregoing paragraphs we have seen the commencement of a model of the Shamokin and Mahanoy coal basins in Pennsylvania, and rejoice at the adoption of this excellent mode of representation.

At Bear Gap, towards the western termination of this field, is a fine natural display of out-crops of all dimensions. Like all the anthracites in their progress westward towards the Susquehanna, their specific gravity diminishes, and they become softer. A cubic yard of this coal, here, weighs one ton and seventy-three pounds. Specific gravity, 1.371.

At Shamokin, an immense quantity of coal occurs in the northern rise of the strata, which are here displayed in a double axis. The beds vary from five to eleven and a half feet in thickness, with the exception of the "Mammoth Vein," which consists, it is said, of sixty feet of coal of various qualities and degrees of purity. In general, the Shamokin coal has a white ash: it is a free-burning anthracite, of fair repute in the domestic market, but is considered to be somewhat too soft for the most advantageous application, as a fuel, for a blast furnace. The large vein appears to be identical with that seen at Tamaqua, at the Swatara region, in the Wyoming coal-field, Beaver Meadow, &c. The direction of the Shamokin beds is N. 82° E.

Amount of coal sent to market from the Shamokin district, via a rail road of sixteen miles to Sunbury on the Susquehanna, for the nine years in operation, from 1839 to 1847, inclusive, 119,311 tons. This coal is of the white ash species. We have seen an analysis, which assigns 89.99 as the proportion per cent. of carbon in the harder variety.

SECOND SUBDIVISION, OR MAHANOY BASIN.

This area contains a splendid suite of anthracite beds, none of which have been yet worked, nor has there been made a railroad for conveying the coal to market; so that, at the time we write, this valuable coal basin remains entirely unproductive.

Advancing eastward, we arrive at the Girardville coal works, now temporarily abandoned for want of the means of transporting the coal, but where an enormous development is exhibited. In structure and quality, the anthracite is more solid and ponderous than at the positions mentioned westward; a cubic yard weighing one ton and four hundred and sixty pounds. Specific gravity 1.600.

This extensive coal property, upwards of fourteen miles in length, was the munificent gift to the City of Philadelphia, of the celebrated Stephen Girard, and is destined, ere long, to yield a splendid addition to the corporate revenues. Some years ago it furnished a considerable quantity of anthracite to Philadelphia, but the business has been for some time suspended.

THIRD SUBDIVISION. EASTERN GROUP OF SMALL BASINS.

Retaining, for the sake of convenience, the topographical arrangement heretofore in general use when speaking of the Pennsylvania anthracite districts, we have to remark that this is much more complex in its physical features than the southern region, which we have previously noticed. We shall convey the best idea of this middle region, by describing it as made up of a somewhat numerous series of troughs or elongated basins, and separated from each other by as many anticlinal axes or flexures, which commonly bring up to the summits of the ridges the underlying red sandstone and shales. So frequent are these undulations, that on one estate of eight miles in length which has come under our examination on the eastern portion of the region, we observed six or seven of these nearly parallel basins, whose

prevailing direction is about ten degrees to the north of east. The general surface is thickly covered with diluvium, so as to conceal the out-crops of the coal seams; but in general there is an unusual agreement between the configuration of the surface and that of the basins themselves: the coal measures, which are the highest strata in geological position, occupy the bottoms of the ravines, while the red shales and sandstones, upon which the anthracite is imbedded, ascend from beneath them to the highest crests of the mountains. Thus, therefore, we learn to regulate our researches by the general rule, and seek for the superior rocks in the lowest positions, or the synclinal valleys.

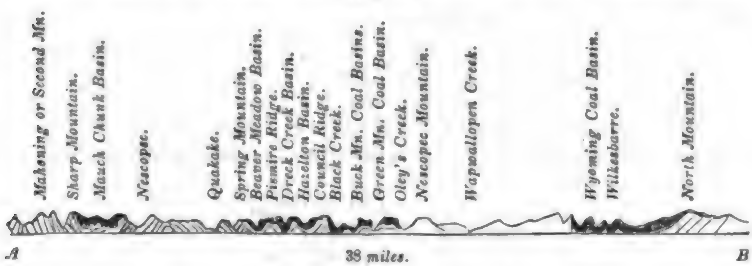
Taking these local basins either as a group or individually, we find them much shallower than occurs in the Pottsville region. This fact was also inferred by Mr. Logan, from the frequency with which the conglomerate is brought to the surface.* In the present instance, too, we are struck with the circumstance of the greatly reduced thickness of the entire coal series and subjacent conglomerate, as compared with the same rocks in the southern field; even so near as Tamaqua, eight or ten miles only to the south.

The basins of which we have been speaking, are separately indicated, with his usual perspicuity, by Prof. H. D. Rogers, in his third annual report.† Details of these are doubtless reserved for the final report of that survey. In the meanwhile we may observe that this country contains many associations for the working of anthracite deposits. Most of these companies have published statistical reports of their respective localities, with maps, analysis, and other suitable illustrations. During the last five or six years prior to 1846, the development of these valuable depositories of mineral fuel proceeded with languor, owing to the financial embarrassments of the country. Of late, much of this property has changed hands: new areas have been laid open, and a spirit of activity has again manifested itself with the returning prosperity of the times.

The section below represents the relative position of the various anthracite basins which are crossed by a meridian line from Mauch Chunk mines to the Wyoming coal valley, a distance of thirty-eight miles.

Fig. 11.

Transverse Section of the Pennsylvania Anthracite Basins, in a north and south direction, looking west.



The eastern group of coal basins belong to various associated companies. Those which have made the greatest progress in mining coal and making rail

* Proceedings Geol. Soc. London, Vol. III. p. 710, 1842.
† Third Report of the State Geologist, p. 25.

roads, are the Summit Company, the Hazelton, the Sugar Loaf, the Beaver Meadow, and the Buck Mountain Companies. Their workings are chiefly limited to the main seam, or rather to a group of three or four seams, amounting to about twenty-eight feet, the coal of which is a remarkably pure anthracite, highly esteemed. Our notice of these establishments must be necessarily brief.

The *Summit* Coal Company's operations until lately have been carried on, in great measure, as an open quarry, not possessing a rock roof. The entire mass is estimated at twenty-seven feet thickness, in four beds or divisions, and from the undulation of the strata, it is brought up two or three times to the surface within the general area. The works are recently carried on by means of a vertical shaft, and the produce is as follows:—

In 1846	11,868 tons
1847	32,280 "

The *Hazelton* mines are worked by "slopes" and steam-power, on both the north and south sides of the basin; that is to say, dipping in opposite directions to the centre. About twenty feet thick of coal, in three seams, are mined at this colliery. The basin contains two or three smaller beds, as at the summit mines. The specific gravity of the coal is 1.550.

Amount of coal sent down to market from the commencement of the colliery in 1838 to 1844, inclusive, was

	271,066 tons
In the year 1845	70,659 "
" " 1846	98,150 "
" " 1847	105,766 "
Total	545,641

The *Sugar Loaf* mine takes the coal of the north slope of the Hazelton basin, and from the same general bed.

The aggregate in four years, ending 1845, is 85,439 tons only. Circumstances of a financial character have interrupted the coal operations for two or three years, but they are now on the point of renewal on an enlarged scale.

Beaver Meadow Colliery exhibits a considerable section of coal, raised by steam power. A cubic yard of this splendid anthracite weighs one ton and four hundred and sixty pounds. Its analysis, together with that of the other mines we have enumerated, appear in our general tables. The returns from the Beaver Meadow mines commenced in 1837. From that year to 1842, inclusive, a period of six years, the aggregate sent to market was

	231,894 tons
In 1844	70,379 "
" 1845	77,227 "
" 1846	85,648 "
" 1847	109,363 "
Total	574,511

The *Buck Mountain* contains four coal seams, the thickest being twenty-two feet. The company here sent down

In 1843	2,844	tons
" 1844	13,749	"
" 1845	23,914	"
" 1846	46,103	"
" 1847	50,847	"
Total	137,457	

There now exist facilities, by means of several rail roads, and by the Lehigh Navigation on the east, by the Schuylkill Navigation on the south, and the Pennsylvania Canal on the west, for transporting to tidewater an unlimited supply of a mineral fuel, unsurpassed in point of purity, probably, in the world. So late as 1834, the Coal Committee reported to the state legislature that " the whole quantity of coal mined in this middle anthracite region, was estimated at only five hundred tons, which were hauled in wagons to supply the neighbouring districts." What has been accomplished since, appears from the preceding notes, and show an aggregate production within a very few years, of about a million and a half of tons.

III. THE NORTHERN OR WYOMING, WILKESBARRE, AND LACKAWANNA, ANTHRACITE REGION.

In the western half of this elongated basin, the coal formation occupies the beautiful valley of Wyoming; the remainder extends eastward to the Carbondale works, the coals of which almost entirely go to New York, and are of first rate quality.

In geological character this is but a repetition of the first and second coal fields below, although it has been less disrupted. Mr. Logan constructed a transverse section in 1842. Mr. Featherstonhaugh had made one in 1830. Here are several coal seams, varying from three to thirty-two feet thick; but their number is not yet fully ascertained.* Near Wilkesbarre, the principal coal mine or bed, consists of a series of layers, amounting to twenty-nine feet thickness; of which only eighteen feet are, or lately were, worked. This is mined by leaving pillars of fourteen or sixteen feet square, and the coal is extracted by blasting; commencing with the upper seams. There are several mines towards the west, from this position; some of which are accessible from the Susquehanna river. They are worked by means of open galleries, twenty to twenty-four feet in height. These are generally of the denomination of red or grey ash coals; those to the eastward are commonly of the white ash kind.

It was formerly thought that the Wyoming coals were inferior in quality to those of the other districts. This evil reputation was, in great measure, derived from the impolitic method of mining, during the early years of coal operations in this valley, whereby much inferior coal was permitted to go to market. Where regard is had to a proper selection of the purest seams, or parts of seams, the coal is entitled to a character equal perhaps to that of

* Silliman's Journal, 1830. Also Hazard's Register, vol. x. p. 319.

any other. In fact, there is here, as in every part of the anthracite fields of Pennsylvania, a great variety of coal, even in the same general seam.

The existance of this combustible was, apparently, known much earlier, than that of the southern coal-fields; and we are informed that it was furnished to the United States armory at Carlisle, in 1775 and 1776; but that it had been in use since 1768, in small quantities.

Carbondale is the most important working point from the Lackawanna region, at its north-east end; from whence, in 1829, a railroad and the Delaware and Hudson Canal were opened to convey the coal to the Hudson river, and thence to New York; the amount transported the first year being 7000 tons.

In 1834 and 1845, the capital invested in this coal undertaking, was stated to be as follows:

	1835	1845
Canal and Railroad, 123 miles, -	$2,305,599	2,910,558
Colliery establishment, canal boats, lands, &c.	862,501	245,971
	$3,168,100	3,156,529

In 1828, there was but a solitary house on the site of Carbondale. It contained in 1833, 2000, and in 1840, 2,398 persons, chiefly employed by the company, or in transportation, &c.

There is no description of fuel, for the use of the Hudson river steam vessels, in higher repute than the Lackawanna coal.

Table of the amount of Anthracite exported from the Northern Basin or Division.

	Lackawanna District.			Wyoming or Wilkesbarre District.		Total.
Years.	Tons.	Years.	Tons.	By Canal and River.	By Lehigh.	Tons.
1829	7,000	1839	122,300	Tons.		76,321
1830	43,000	1840	148,470			122,300
1832	84,600	1841	192,270			148,470
1833	111,770	1842	227,605	32,917		225,187
1834	43,700	1843	242,000	47,246		274,851
1835	90,000	1844	251,005	57,740		299,740
1836	106,270	1845	269,469	116,018		367,023
1837	115,387	1846	318,000	178,401		451,836
1838	76,321	1847	388,203	192,503	5,865	516,368
				289,898	10,246	678,801

The quantity thus far registered, as sent from this region between 1829 and 1846, inclusive, is 3,732,686 tons; which is evidently less than the amount exported from the basin, besides the home consumption. It is impossible to tell the amount which passed down the river.

The coals of the Lackawanna or Carbondale district are transported to New York by the Delaware and Hudson Canal, 108 miles; railroad, 18 miles; and river navigation, 91 miles. Total, 217 miles.

The coals of the Wyoming district descend the Susquehanna 194 miles, to tide at Havre; the returns are from the Canal Commissioners reports; distributing coal at numerous points along the river.

Passed the Tide water Canal in	1845	58,131 tons.
" " "	1846	67,905 "

Lith. of Wagner & Mc Guigan Phila

The Lackawanna is considered the lightest of the white ash coals that come to market; the usage of the trade formerly assigned thirty-three bushels to the ton; Schuylkill thirty, and Lehigh twenty-eight bushels. Our tables of specific gravities of the whole series of Pennsylvania anthracites will, however, best exemplify this.

Mr. Logan, in a communication to the Geological Society of London, in 1842, states that he had taken some pains to construct a section of the Wyoming basin, at Wilkesbarre; and furnishes the details of the formations there. The coal beds, he estimates at 14 or 15 in number, with an aggregate thickness of 70 to 80 feet.

IV. BROAD TOP MOUNTAIN—SEMI-BITUMINOUS COAL-FIELD IN BEDFORD AND HUNTINGDON COUNTIES.

The area of this small detached coal-field we have not seen announced. Our own calculation is about forty square miles.

Of how many coal seams this basin is made up, we have not ascertained, beyond the six or seven that we have examined. They vary in thickness, from three to eight feet. An article in the Transactions of the Geological Society of Pennsylvania, by the present writer, in 1835, furnishes, in conjunction with the Section, Pl. VII., a view of the principal geological features of this coal-field. The analysis, in the same paper, furnished by Mr. T. G. Clemson, shows not more than 17 per cent. of volatile matter, and 70 per cent. of carbon.

An analysis from coal of this region, in the State report, shows only 11 per cent. and 84 per cent. of carbon; while a third examiner, Johnson, finds 16 per cent. of the one and 77½ per cent. of the other.

The requirements of the neighbouring iron works, &c., occasion but a small amount to be annually mined; while the insulated position of the coal-field, in the absence of a canal or railroad, prevents a coal business of consequence being done here to advantage. There are no returns on record of the quantity produced in this small region, for the reasons assigned. The peculiar character of this coal, which greatly resembles the Stony Creek coal, although from its remote position it will for many years remain in reserve, must always confer a high value upon it for furnace, foundry, and steam purposes.* The mountain, in which these coal seams occur, "is a broad irregular plateau, having several spurs, running out towards the bounding valleys."†

REMARKS.

We are aware that, by geologists, the foregoing details of the Pennsylvania anthracite regions may be thought somewhat too statistical. Yet if geology be estimated with relation to its practical usefulness, and in its economical sense:—if it be viewed in its tendency to benefit the community; to designate new channels for productive industry; and,—especially as regards the New World,—to almost boundless sources of remuneration, we need not terminate this portion of our subject with an apology for the abundance of that species of information. It would be difficult, indeed, to select a finer field, wherein to demonstrate the practical and useful applications of the science, than the country from whence we write.

* On certain coal beds near Broad Top Mountain, described under the denomination of "Bituminous Anthracite."—R. C. T. in Trans. Geolog. Soc. of Penn., p. 176, 1835.

† Geography of Pennsylvania, p. 184.

PRODUCTION OF PENNSYLVANIA ANTHRACITE.

In the following summary are exhibited the periodical yearly production of anthracite, and the aggregate amount of tons sent to market by various avenues, at the corresponding periods. Of the home consumption for domestic use, for manufactories, blast-furnaces, forges, rolling-mills, and the coal which is conveyed by other routes from the mining districts than the railroads and canals, we possess no returns or direct means of judging.

As the best illustration of the rapid progress of the coal trade, and of its influence on the domestic commerce of Philadelphia, since the opening of the mines, we annex to our table, in the fifth column, a statement of the enrolled and licensed tonnage of Philadelphia, and in the sixth column, the coastwise arrivals at the same port, and in the corresponding years.

Years.	Periodical increase.	Sent to market in given years.	Aggregate supply at corresponding periods.	Enrolled and licensed Tonnage of Philad.	C'stwise arrivals at Philad.
		Tons.	Tons.	Tons.	Vessels.
1820	First cargo of coal sent to Philadelphia. In this year there were raised at Mauch Chunk, in the Lehigh region, which continued the only source of supply for five years,	365	365	24,117	877
1825	The first returns from the Schuylkill coal district, and which, with Mauch Chunk, formed the two sources for four years,	34,893	53,935	29,421	1195
1829	First returns from the Lackawanna district, which, added to the former, produced in the three coal regions, during five years,	112,083	355,015	27,494	2210
1834	The Swatara district opened, forming the fourth, for three years,	383,547	1,941,735	46,653	2686
1837	A fifth region, the Beaver Meadow, came into operation,	881,026	4,131,548	58,237	7776
1838	Another colliery, the Hazleton, in the middle region, now commenced, and, with the five others, sent to market,	739,293	4,870,841	60,161	10,860
1839	The Shamokin and the Sugar Loaf mines, now contributed to the supply, altogether furnishing	819,327	5,690,168	63,790	11,188
1840	The united exportation from all these localities was	865,414	6,555,582	67,045	9,706
1841	The Wyoming, or Wilkesbarre district, now first appears in the returns, 32,917 tons. To this may be added the amount mined, during several preceding years, by the Lykens Valley Company, estimated at 60,000 tons,	1,108,899	7,607,398	71,588	11,738
1842	General production this year,	1,018,001	8,715,399	100,641	10,457
1843	Includes the first returns from the Buck Mountain,	1,263,539	9,978,938	104,340	7,659
1844	General production,	1,631,669	11,610,607	114,894	8,016
1845	General production, including many new collieries,	2,023,052	13,633,659		11,476
1846	General production comprises a great number of mines, opened within a few years, particularly in Schuylkill Co.,	2,343,992	15,977,651		14,971
1847	General production, business increase 638,317 tons,	2,982,309	18,959,960		18,069

There are various tables in circulation, but none are complete in all the details. In compiling the foregoing statement, we have adhered to the official returns of the various companies as far as possible, assisted by the

annual summary published in the Pottsville Miners' Journal, and the Philadelphia Commercial List.

PHILADELPHIA, READING AND POTTSVILLE RAILROAD,

For the Transportation of Anthracite.

The increasing demand for the anthracite of Pennsylvania, the rapid introduction of this combustible into most of the Atlantic states, and the cities of the seaboard, for domestic purposes as an economical substitute for wood, and its enlarging consumption in manufacturing establishments, and almost every where, where steam was the moving power, accelerated, at a corresponding rate, the requirements of the owners and uses of the collieries for adequate facilities of transportation.

The project of a continuous railroad from the mines of Schuylkill county to the river Delaware, the nearest point of shipment at Philadelphia, first received the legislative sanction in 1833, and in 1835 the arrangements having been organized, the work was commenced.

On the 16th of July, 1838, the railroad between Reading and Norristown, uniting there with the Philadelphia and Norristown railroad, altogether a distance of fifty-four miles was opened for the conveyance of passengers. In December, 1839, the line of railroad between Philadelphia and Reading was opened for transportation. Subsequently, the works were extended at its southern extremity to its terminus at Richmond, on the Delaware, near Philadelphia, and northward to Port Carbon, near Pottsville. On the first day of January, 1842, the first locomotive and train passed over the whole line, between Pottsville and Philadelphia, a distance of ninety-three miles.

The following statement exhibits the amount or quantity of coals conveyed on this railroad, and the receipts for transportation of the same, from the commencement, in 1841, for the years ending November 30th, annually, compiled from the annual reports of the Company.

Years.	Tons of 2240 lbs. of coal only.	Freight and toll for coal.	Freight per ton.
1841	850		
1842	49,752		
1843	218,711	$278,840	$1.27
1844	421,958	448,508	$1.06\frac{3}{10}$
1845	814.279	886,939	$1.08\frac{9}{10}$
1846	1,188,258	1,600,667	1.35
1847	1,360,681	1,698,664	1.25
Total,	4,054,489		

From the same official reports we perceive that the amount of running machinery, in employment in each year, on this railroad, was as follows:

Machines, Cars, &c.	1843	1844	1845	1846.	1847.
Locomotive Engines,	31	47	54	72	77
Coal Cars,	1592	2456	3104	4559	4606
Freight Cars,	208	265	294	482	502
Passenger and Baggage Cars,	19	19	21	19	22
Extra Cars for wood tenders, &c.			46	34	
" Stationary Engines, and Portable Steam Engines,			4	13	
" Locomotive Engines,			1	2	
Horses,			31	50	

The number of passengers transported, the receipts for their fare, and the number of miles travelled, are thus:

Years.	Number of passengers.	Miles travelled.	Receipts.
1843	56,554	2,457,439	$71,895
1844	66,503	3,159,909	92,362
1845	63,719	3,049,422	103,411
1846	88,641	4,154,214	141,749
1847	97,463	4,560,260	156,201

The total length of lateral railroads connecting with the Reading railroad, under other charters and corporations, but all contributing to its business, using its cars, and returning them loaded with coal, was about ninety-five miles, in 1846.*

According to the annual general account of the company for the year ending 30th November, 1846, the total cost of the railroad, locomotives, cars, real estate, depots, and materials, is $11,589,696.

During the year 1846, there were cleared from Port Richmond, the shipping depot of this company, on the Delaware,

	Number.		
	7,485	vessels, carrying 892,464	tons† of Schuylkill coal.
Also	1,468	" 181,792	" Lehigh coal.
Total	8,953	1,074,256	

In 1847, 11,439 from Port Richmond.

SCHUYLKILL NAVIGATION,

For the transportation of Anthracite—length one hundred and eight and a quarter miles, lockage six hundred and twenty feet.

This canal, which was commenced some years before the importance of the Pottsville coal-field was known, or even suspected, affords, through the annual reports of its directors, an unerring criterion of the rapid advancement of the coal trade.

Table of the annual number of tons of Anthracite, the amount of toll received thereon, and the average rates of toll per ton on the Schuylkill Navigation, from the commencement of its coal trade in 1825; *compiled from the company's annual reports.*

Years.	Tons.	Toll.	Per ton.	Years.	Tons.	Toll.	Per ton.
1825	6,500	$9,700	$1.49	1839	442.608	$381,198	$0.86
1828	47,284	46,201	0.97	1840	452,291	373,400	0.82
1830	89,984	87,192	0.97	1841	584,692	482,460	0.82
1832	209,271	199,784	0.95	1842	491,602	235,544	0.50
1834	226,692	204,490	0.90	1843	447,058	260,724	0.58
1835	339,508	310,475	0.91	1844	398,887	169,680	0.43
1836	432,045	399,472	0.91	1845	263,587		0.33
1837	523,152	484,799	0.92	1846	3,440	closed.	0.33
1838	433,875	385,024	0.88	1847	222,693		

* Miners' Journal, January 23d, 1847.
† Philadelphia Commercial List, January 16th, 1847.

M. Chevalier correctly remarks, that the value of this anthracite region [gisement] has literally become immense; and its workings [exploitation] have accomplished a revolution in the domestic economy of the Atlantic states.* This canal was commenced in 1817, but it was not until 1825 that anthracite commenced to form the principal part of its tonnage.

In 1833 the number of canal boats used on the Schuylkill Navigation, was 580.

In 1843 the number of loaded canal boats which passed down the Schuylkill Navigation, was as follows—

Covered boats, adapted to the direct trade from Pottsville to New York, averaging sixty tons, - - - - - -	278
Open canal boats, for coal, - - - - -	434
Lime boats, and miscellaneous, - - - - -	58
Registered, as passing the Fairmount locks - -	770

The usual boating season is thirty-five weeks, annually.

The tonnage has been annually advancing, from 32,000 tons in 1826, to 540,000 tons in 1845. The charges on the transportation of coal have been reduced during this period.

In 1826 the tolls received amounted to somewhat less than	1½	cent	per mile.
1843 the whole charge, including freight and toll, "	1¼	"	"
1845 " " " (toll ⅓ of 1 cent) "	1	"	"

The actual toll received each year from 1825 to 1845, is shown in the preceding table.

In the latter year, the universal voice of those concerned in the coal business, and of the great body of residents and proprietors of manufactories along the line, having for some time called for further improvement of the navigation, the stockholders resolved to enlarge the works, so as to pass boats of three times the former tonnage. Accordingly, the whole of the season of 1846 was devoted to this undertaking, and the navigation was necessarily suspended during that year.

Four thousand men were employed on these works, and it was with great difficulty that an adequate supply of mechanics could be raised to carry on the work with a rapidity commensurate with the wishes of the directors.

Amidst many difficulties and embarrassments, caused by repeated freshets and the destruction of half completed works, the great object was accomplished at the close of 1846, in a satisfactory style, and with a rapidity which admits of no parallel in the history of the internal improvements of this country. The report of the president and managers of the company, 4th January, 1847, details all these circumstances, and the final result.

The capacity of the present navigation, is therein stated as being nine times as great as the canal when originally opened to the trade. It now averages more than seventy feet in width, and six feet deep. It is adapted for boats of not less than one hundred and eighty tons burthen, and will be adequate to the convenient transit of a million and a half of tons.

The aggregate investment of the company on the 1st January, 1847, including all liabilities, as well for the construction of the work as for boats and cars, &c., amounted to $5,785,667.

Besides the canal boats specified above, the company possess three hundred cars, to run upon the lateral railroads.

* Histoire et description des Voies de communication aux Etats-Unis, par M. Chevalier. Paris, 1840.

Quantity of Schuylkill Coal annually sold in Philadelphia for home consumption, which descended by the Schuylkill Navigation.

	Years.	Tons.	Years.	Tons.
Delivered at Philadelphia,	1836	61,944	1841	89,000
	1837	71,916	1842	88,000
	1838	98,707	1844	97,600
	1839	100,694	1847	226,610
	1840	90,000		

The registration of the consumption in Philadelphia, appears to have been discontinued. The quantity which was received by Philadelphia in the year 1847, by railroad, was 203,540 tons.

Freights of Schuylkill Coal annually from Pottsville in the month of October in each year, per ton.

		1844	1845	1846	1847
Freight and Toll From Pottsville	To Philadelphia by Canal,	$0.85	1.90		2.00
	To Philadelphia by Railroad,	1.25	1.40	1.70	
	To Richmond, - -			1.60	2.00
	To New York, - -	2.25	2.50	2.70	
Freights From the Depot at Richmond on the Delaware	To New York, - -	1.00	1.10	1.00	1.30
	To Albany and Troy, -	1.50	1.50	1.45	
	To Hartford, Con. - -	1.65	1.65		
	To Salem, - -				2.37½
	To Boston, - - -	1.70	1.70	1.60	2.50
	To Fall River and Providence,	1.35	1.40	1.30	1.80
	To Baltimore, - -			.75	
	To Washington, - -			.80	

On the enlargement of the Schuylkill Navigation, in 1846, it was estimated by the directors that the actual cost of freight from Pottsville to New York, with an adequate supply of large boats, would be about $1.35 per ton. The freight in August, 1847, was, however, $2.00 to Richmond only.

The direct exportation of coal from the Schuylkill region, which descended the Schuylkill Navigation and the Delaware and Raritan Canal, to New York.*

Years.	Loaded Canal Boats.	Tons.
1839		27,000
1840		64,388
1841	1,354	78,296
1842	2,243	126,554
1843	2,045	119,972
1844		111,521
1845		116,610
1846 Nav. suspended.		

We have seen a statement, purporting to exhibit the importance to Pennsylvania of the trade in anthracite:—that in the year 1845, independent of the quantity consumed in the State, there were shipped to other states, as

* Annual Reports.

much coal as amounted at the average value [$4.00 per ton,] at the place of shipment, to the sum of $5,000,000.* In 1847, the value of the anthracite shipped at tidewater for other states, was not less than $10,000,000.

COMPARATIVE VALUE OF THE ANTHRACITE OF PENNSYLVANIA.

With the exception of iron, in the mining and manufacture of which, according to the census returns of 1841, more than twenty millions of capital were employed in the United States,—nearly eight millions of which appertained to Pennsylvania,—the coal production of this State then gave employment to more workmen, and more capital than all the other minerals in the Union combined, or more than 2½ times; as is shown in the following table:

	United States in 1840.			Pennsylvania in 1840.		
	Lead.	Gold.	All other Metals.	Anthracite.	Bituminous Coal.	Total Coal.
Men employed in mining	1,017	1,046	728	2,997	1,798	4,795
Capital invested, -	$1,346,756	$234,325	$238,980	$4,334,102	$300,416	4,634,518
Exclusive of the canals railroads, Persons,	2,791	Sum tot.	$1,820,061			

In 1847, the capital invested in the canals and railroads, communicating with the anthracite regions of Pennsylvania alone, amounted to more than forty millions of dollars. This is wholly independent of the capital employed in the coal regions, and the trade consequent upon it.

RAPID AUGMENTATION OF PRODUCTION AND CONSUMPTION.

With the exception of the two distressing years, from 1841 to 1843, when every species of property was alarmingly depreciated, and all business appeared to be paralyzed, the anthracite trade in its various departments, although not yielding enormous profits, steadily and rapidly acquired importance, from the period of its commencement. Each succeeding year saw new fields explored; new deposits discovered; more enterprise exerted in opening approaches from the seaboard to the coal beds, and more avenues for the transportation of the mineral fuel through the wilderness; more capital invested in this fruitful branch of industry and commerce. Each year added to our acquaintance with the extent, the limits, the existence, of these vast carboniferous masses; and advanced our progress in the science of industrial and economic geology. As in the building of the mighty Egyptian pyramid, each year saw arise, with augmented bulk, and still increasing magnitude, that immense fabric which had commenced from nothing.

The time has not yet arrived when an elaborate description of the Pennsylvania coal-fields can be satisfactorily presented. That task will, no doubt, ere long be executed by able hands, under all the advantages which the influence and the resources of the State government can confer. In the mean while, a selection from the notes which have accumulated under the author's hands,—although derived from sources common to all,—in the absence of

* Anthracite Gazette, Feb. 7th, 1846.

data more scientific, and of statistics more official, will be the best substitute he can offer.

The following table in the diagram form, so far as extends down to 1842, is compiled by adding to the amount sent to market in each year, the quantity of coal on hand at its commencement, and deducting the surplus remaining at its expiration. The succeeding years represent the production, annually. From 1842 to 1848, the returns are of the amount which reached tide.

Adhering to the metaphor which he has employed, the writer presents his readers with a diagram of this statistical pyramid;—built, not with granite, nor sienite, nor ponderous marble, but with Pennsylvania anthracite, and reared by her industrious citizens and free labourers.

Which of the two fabrics,—that "of the olden time," or this, in the building of which most of us have had a hand,—is most conducive to "the good use of man?" let the economists say.

Mr. Gliddon tells us, that the Egyptians, in days of yore, builded their pyramids "from the top downwards"—and so, too, have we constructed *our* pyramid. We are, therefore, not without good precedents, as venerable as they are substantial, for such a practice.

And now let us compare our work with theirs.

We are told that it employed 100,000 men, during twenty years, to construct the Pyramid of Cheops, or Shoopho, and that ten preceding years were requisite merely to prepare the materials, and to convey them from the quarry, a distance of twenty miles. Now this, the largest of all the pyramids, contained an area of 3,300,000 cubical yards. Allowing the ordinary computation, that a cubic yard of anthracite is equivalent to one ton in weight, and as we have brought up from the bowels of the earth about nineteen millions and a half of cubic yards or tons, and have conveyed them an average distance of at least one hundred and fifty miles, we have, in twenty-five years, acquired materials about sufficient for the erection of six such structures, united in one. Such are the colossal proportions of our Pennsylvania Pyramid.

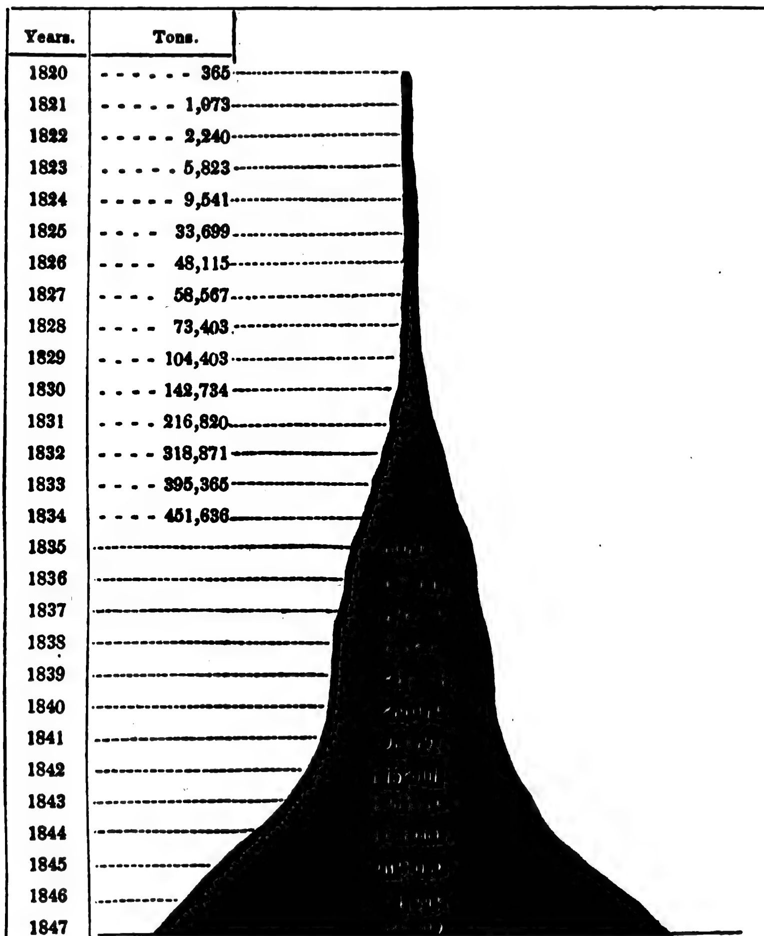
To be sure, the outline is not symmetrically beautiful, nor in that strict geometrical proportion which the eye delights to dwell on, or which the architect loves to contemplate. True, its upper portion is somewhat too attenuated; but, then, we make it up in the base. At the beginning of the work, we admit, the outline had more of the spire than of the pyramid about it; but then we were short-handed; and, moreover, as soon as we discovered our error, we lost very little time in correcting that, as the books show; and we soon adopted more substantial proportions.

The base is now so broad and so firmly planted, and the structure has withstood such heavy storms of late years, that no fears for its permanence and future increase can now be entertained.

Success, then, to our great Pennsylvania Pyramid! May its proportions increase and overshadow the land!—may it ensure protection, security, and prosperity to all who seek its shelter, or who labour around its base!—to all who contribute towards its enlargement!

Fig. 12.

STATISTICAL PYRAMID OF THE ANNUAL CONSUMPTION OF AMERICAN ANTHRACITE.



ANTHRACITE.—STATISTICS OF PRODUCTION.

Lehigh Company's Mines. So rapid was the increase in the demand for anthracite, after the export trade commenced in the year 1825, [although the home market originated in 1821,] that in ten years, as appears from the official returns in 1835, the number of coasting vessels that received freights of the coal which had descended the Delaware, was one thousand and sixty-nine.

Amount of Anthracite sent down from the Company's mines at Mauch Chunk and Room Run.

	Years.	Tons from the Co.'s mines.	Years.	Tons from the Co.'s mines.
11 years, previously to	1831	207,887	1841	78,164
	1831	44,683	1842	163,762
	1833	123,441	1843	138,826
	1837	200,000	1844	219,245
	1838	154,693	1845	257,740
	1839	142,507	1846	274,623
	1840	102,264	1847	334,929

General statement of the Coal conveyed on the Lehigh Navigation.

Until so late as 1837, the only coal sent down to market was from the Lehigh Company's own mines, in the Southern Region.

Years.	Periodical increase.	Tons of coal transported.	Tolls chiefly arising from coal.
*1836	The annual quantity had increased from 365 tons in 1820 to	148,211	$110,905
1837	By the addition of the Beaver Meadow coal from the 2d District	224,095	149,266
1838	The Hazleton Company's mines came into operation, and the whole	214,211	125,411
1839	The Sugar Loaf mines commenced in addition, making this year	221,850	141,300
1840	Additional mines were put in work in the 2d Region, in this and following years.	225,585	143,335
1841	The reduction is owing to the damage to the canal by a freshet.	143,038	65,792
1842	Quantity sent down by the Lehigh Navigation,	272,553	157,844
1843	" " " " " (some delay on account of strike of boatmen,)	267,826	173,660
1844	A considerable improvement in the trade of this year.	377,094	170,759
1845	A very favourable year for transportation.	429,492	203,405
1846	do. do. do.	522,297	
1847	do. do. do.	643,612	

Shipments of Lehigh Coal from Bristol to Philadelphia, and ports on the Delaware.

Years.	Tons.	Years.	Tons.	Years.	Tons.	
1821	525	1834	80,000	1842	50,780	
1825	11,245	1835	85,000	1843	77,840	Lehigh Co. Others no separate account kept since 1844.
1830	12,601	1839	42,000	1844	35,972	
1833	25,000					

* History of the Lehigh Coal and Navigation Company, 1840, p. 61.

† Annual reports of the Managers. The separate amounts of toll on the coal are not distinguished in the published returns.

LEHIGH COAL STATISTICS.

The following table from the Pennsylvania Canal Commissioners' annual reports, shows the amount of anthracite received on the Delaware division of the State Canal, at the undermentioned points.

	1844.	1845.	1846.	1847.
	Tons.	Tons.	Tons.	Tons.
Sent southward from Easton,	301,956	392,821	522,990	
Received at Bristol,	290,105	335,199	387,786	450,178

Shipments and clearances from Philadelphia and Bristol, laden with Lehigh coal, in 1846, 1468 vessels, exclusive of boats, carrying 181,792 tons.*

Summary of Coal brought to Tide from the three principal regions.

	1845.	1846.	1847.
	Tons.	Tons.	Tons.
The aggregate of coal brought down by the Lehigh Navigation from the commencement of the trade in 1820, including that from the Lehigh Company's mines, the Beaver Meadow, Hazleton, Sugar Loaf, and other collieries, to 1845-6-7, [exclusive of 81,985 tons from Shamokin conveyed by another route,]	3,205,734	3,635,187	4,313,085
The Schuylkill region had produced up to the same period, [exclusive of 233,282 tons from Pinegrove,]	7,392,744	8,953,098	10,587,054
The Northern region *sent to market by the usual avenues*,	2,576,473	3,088,341	3,767,142

In the annexed diagram, bearing the title of "*the Stream of the Lehigh coal trade*," we have exhibited, under one view, the whole extent, past and present, of the trade, from its origin. We represent, in this sketch, the main stream and the lateral channels through which the anthracite finds its way to market. True it is, the stream has heretofore flowed somewhat irregularly; sometimes embarrassed by natural obstacles and unexpected calamities; sometimes interrupted by temporary causes; yet has it ever pursued its accelerated course, and onwards advanced in an accumulated volume. Notwithstanding every check, always has it surmounted all barriers; always maintained its progressive character. Always has it given promise, in no distant time, of a mighty flood; prolific—fertilizing—reproductive. Success, then, to the *Stream of the Lehigh coal trade!* Onward may it flow; swelling in its volume; bearing on its surface and in its inmost depths, the elements of prosperity to all who embark upon its waters! For ourselves, and in our day, we perceive but the beginning. We approach but the fountain head:—the margin of a stream to whose capacity we can suggest no ultimate limit. We see, but darkly, the outline of that magnificent future, to which all things are tending, when its projectors shall cease to exist.

* Philadelphia Commercial List, 16th January, 1847.

Fig. 13.

THE STREAM OF THE LEHIGH COAL TRADE, DURING TWENTY-EIGHT YEARS.

Mauch Chunk to Easton.	
Years.	Tons.
1820	365
1825	28,393
1830	41,750
1835	131,250
1838	214,211
1840	225,585
1842	272,553
1843	267,826
1844	377,094
1845	429,453
1846	522,297
1847	643,971

Passed up Morris Canal.	
Years.	Tons.
1843	30,000
1842	20,608
1841	2,755
1840	30,210
1839	48,431
1838	48,700
1836	23,000

Easton to Bristol.	
1836	112,082
1838	151,788
1840	171,210
1842	211,817
1843	197,000
1844	290,105
1845	335,199
1846	387,786
1847	450,178

Passed up Raritan Canal.	
1847	134,667
1845	30,985
1843	49,160
1842	43,649
1839	21,000
1838	11,679
1836	20,009

Shipped to Philadelphia.	
1821	525
1825	11,245
1830	12,601
1842	50,780
1843	77,840
1846	181,792

Shipped for Eastern Ports.	
1823	62
1825	25,528
1830	15,271
1838	30,000
1839	4 4,000
1842	117,397
1843	120,826
1844	130,074

EXPORTS OF ANTHRACITE FROM THE SCHUYLKILL AND DELAWARE.

Statement of the number of tons of anthracite, which had descended from the Lehigh and Schuylkill navigations, and which were shipped for exportation *coastwise*, together with the number of vessels of all sorts, [brigs, schooners, and sloops,] freighted therewith at Philadelphia or Bristol.

This statement is exclusive of the coal which passed through the Delaware and Raritan, and the Morris canals.*

Lehigh Coal, shipped coastwise from Bristol and Philadelphia.			Schuylkill Coal, shipped coastwise from the Delaware, at Philadelphia and Port Richmond.		
Years.	Vessels cleared.	Tons.	Vessels cleared. No.	Tons.	
1822			4	181	
1825			190	19,378	
1830			644	63,137	
1833	322	30,753	2,010	198,168	
1835	1069	70,194	2,361	267,139	
1836	261	30,076	3,225	344,812	
1837	51	6,549	3,070	328,304	
1838	96	38,977	2,695	278,268	
1839	158	44,000	2,561	286,990	
1841			3,065	367,812	
1842	From Bristol.	117,397	2,134	256,080	
1844	1127	130,074			
1846	1468	181,792	7,485	892,464	From Port Richmond only.
1847			11,439	1,375,000	

PRICES OF ANTHRACITE IN PHILADELPHIA.

Average Retail Prices for unbroken Coal, delivered in Philadelphia, per ton of 2240 lbs., chiefly derived from the Commercial List, and from Bicknell's Reporter, and the Pennsylvania Inquirer.

Years.	Lehigh White Ash.	Schuy. Red Ash.	Years.	Lehigh White Ash.	Schuylkill Red Ash.
1828	$6.50	$7.00	1840	$5.50	$5.50
1830	6.50	6.50	1842		4.25
1832	6.00	6.00	1844		3.50
1834	5.00	5.25	1845		3.50 to 4.00
1836	6.00	7.50	1846	4.50	4.25 to 4.50
1838	5.50	6.00	1847	5.00	4.50 to 4.75

See also the diagram of Lehigh prices of anthracite, [Fig. 14.]

These prices are, of course, only approximate.

The *Schuylkill white ash coal* has of late years almost superseded the use of *Lehigh coal*, in Philadelphia, and is usually retailed at 25 cents per ton, below the Schuylkill red ash.

See diagram. [Fig. 15.] Schuylkill prices of anthracite.

* Partly taken from the Commercial List of Philadelphia, Jan. 9, 1847.

Fig. 14.

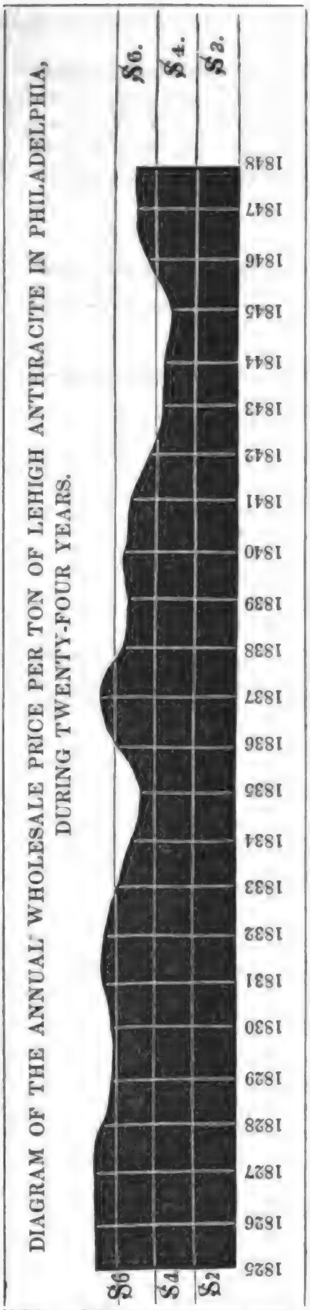


DIAGRAM OF THE ANNUAL WHOLESALE PRICE PER TON OF LEHIGH ANTHRACITE IN PHILADELPHIA, DURING TWENTY-FOUR YEARS.

Fig. 15.

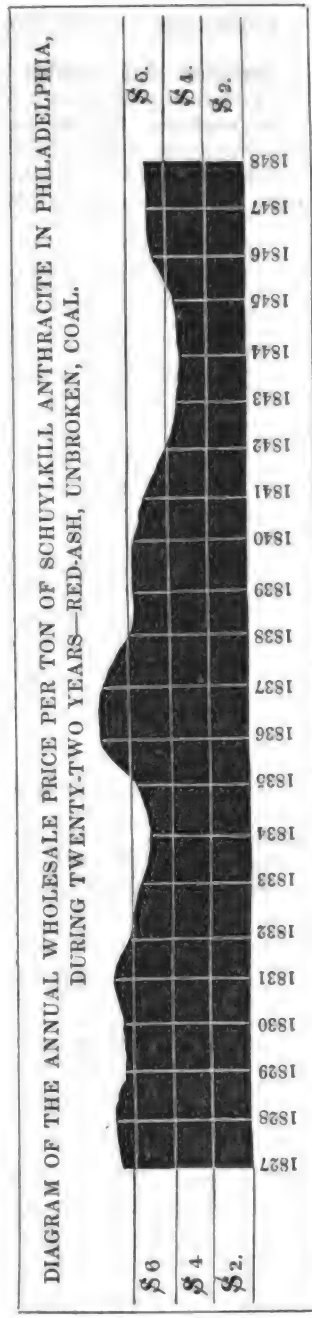


DIAGRAM OF THE ANNUAL WHOLESALE PRICE PER TON OF SCHUYLKILL ANTHRACITE IN PHILADELPHIA, DURING TWENTY-TWO YEARS—RED-ASH, UNBROKEN, COAL.

DELAWARE AND RARITAN CANAL.

Pennsylvania coals [Schuylkill and Lehigh] which passed through the Delaware and Raritan Canal to New York.

Years.	*Tons.*		*Tons.*
1842,	171,754		
1844,	267,496		
1845,	372,072		
1846,	339,923	Lehigh Coal,	134,667
1847,	540,200	Schuylkill,	405,533

Number of Canal Boats which cleared from Bristol, on the Delaware Canal.

Years.	*Boats.*
1842,	4603
1845,	7361
1846,	7785
1847,	9208

Total number of clearances from the port of Philadelphia, in 1846, of coals of all descriptions, 8953 vessels, averaging 120 tons, and containing 1,065,228 tons, in addition to that shipped in boats from the Lehigh.* In the year 1847, the number of clearances of vessels laden with coal, from Port Richmond, near Philadelphia, was increased to 11,439.

Rates of Commission as regards coal, adopted by the Philadelphia Board of Trade.

Commission on Sales,	5 per cent.
Receiving Commission,	10 cents per ton.

DOMESTIC COMMERCE OF PHILADELPHIA.

The following tables show the progressive increase, in periods of five years, of the *enrolled and licensed tonnage*, engaged in the trade of Philadelphia, and of the total *registered*, enrolled, and licensed tonnage of that port; which increase is, in great measure, attributable to the coal trade of Pennsylvania, within the last twenty years.†

Years.	Coastwise. Licensed and enrolled Tonnage.	Total Tonnage registered, enrolled and licensed.	Years.	Coastwise. Enrolled and licensed Tonnage.	Total Tonnage registered, enrolled and licensed.
1791	3,222	57,520	1830	24,236	72,215
1795	7,325	90,946	1835	49,860	86,445
1800	8,032	103,011	1840	67,045	103,944
1805	11,000	87,254	1841	71,588	105,805
1810	15,803	125,258	1842	57,749	100,641
1815	22,360	87,254	1843		104,340
1820	24,117	83,575	1844		114,894
1825	29,421	95,011	1845		

There are a few unavoidable, but not very material, discrepancies in some of these returns, owing to the different sources from whence the data have been obtained.

* Philadelphia Commercial List, 16th January, 1847.

† Statistical Annals of the United States. Adam Seybert, M.D. Phila. 1818, and other authorities.

FOREIGN COMMERCE.

As regards the *foreign commerce of Philadelphia,* our returns exhibit a great falling off, whilst that of New York and Boston has considerably augmented. The following abstract is sufficient to show the relative proportions of the foreign trade enjoyed by these three principal ports.

Table of the Foreign Arrivals and Departures, and of the aggregate Value of the Exports and Imports.

	Philadelphia. Foreign Commerce.			New York. City and State.			Boston and Massachusetts.		
Years.	Vessels entered and cleared.	Tonnage entered and cleared.	Value of Imports and Exports.	Vessels.	Tonnage entered and cleared.	Value of Imports and Exports.	Vessels entered and cleared.	Tonnage entered and cleared.	Value of Imports and Exports.
1821		147,918	$15,550,689		326,435	$48,144,657			
1825		*	25,485,545		543,610	87,057,252			
1830			12,993,915		558,000				$23,528,791
1832		†	14,194,324			79,214,347			25,868,280
1835			16,129,112		834,054	118,536,569			26,596,146
1842	893	173,581	11,152,515	9,166	1,921,810	85,453,000	4,204	662,887	27,794,000
1844	901	168,810‡	7,453,006	12,012	2,895,176	91,088,693	4,865	712,787	27,667,843
1845	787		8,603,912			81,154,479			25,375,658
1846	917	173,000	8,829,925	11,568	3,176,981	111,289,696	5,830	796,721	34,507,073
1847	1,255					147,915,531	4,088		

Value of Exports, domestic and foreign, from the Custom-house returns, from the Ports of Philadelphia, New York, and Boston.

Years.	Philadelphia.	New York.	Boston.
1843	$3,059,171		
1844	3,664,696	$28,526,739	
1845	3,916,833	30,422,672	$9,370,857
1846	5,118,054	35,607,367	8,575,384
1847	8,589,265		

Value of the General Commerce, foreign and domestic.—Imports and Exports.§

Imports and Exports.			
Years.	Philadelphia.	New York.	Boston.
1845	$11,733,590		$30,962,734
1846	13,426,669	$111,289,696	31,202,050
1847	20,725,202	147,915,531	

* Hazard's Regis. of Penna., 1828.
† Dictionary of Commerce.
‡ Geography of Pennsylvania, Trego, p. 145. Commercial List and Philadelphia Prices Current. American Almanac, 1845–7. Hunt's Merchants' Magazine. Niles's Register. M'Culloch's Gazetteer. Emigrants' Directory, 1820. Commerce and Navigation of the U. S., 1844.
§ Custom-house returns.—Commercial List.

In the subjoined statement we have shown the amount of *tonnage, owned, registered, and enrolled,* of three of the principal commercial ports of the United States, at stated periods, whereby the contemporaneous advance of their trade is made apparent—compiled from official returns.

Ports.	1810.*	1831.	1834.	1839.	1843.	1844.	1845.	1846.
	Tonnage.	Tonnage.	Tonnage.	Tonnage.	Tonnage.	Tonnage.	Tonnage.	Tonnage.
New York,	268,548	286,438	359,222	430,000	496,965	525,162	625,875	655,695
Boston,	149,121	138,174	212,536	203,615	201,323	210,885	227,994	241,520
Philad'a,	125,258	79,968	85,520	96,862	104,340	114,894	147,812	148,058

For the more complete illustration of the relative commercial importance of these ports, we have added a table of their *foreign arrivals and coastwise arrivals* respectively, during the years subsequent to 1810.† The later years are from the Philadelphia Commercial List.

	Foreign Arrivals. No. of American and Foreign Vessels.			Coastwise Arrivals.			Coal Trade of Philadelphia.‡	
Years.	New York.	Boston.	Philadelphia.	New York, exclusive of sloops.	Boston, including sloops.	Philadelphia.	Clearances of vessels of all descriptions with coal.	Tons of coal shipped from the port.
1810			405			1,477		
1825			484			1,195	190	19,378
1830	1,510	642	374		2,398	3,287	644	63,137
1832	1,808	1,064	428	4,500	3,538	2,849	1,592	158,442
1834	1,932	1,156	430		3,527	2,686	1,575	156,154
1835	2,094	1,302	421		3,879	3,573	2,361	267,139
1836	2,293	1,452	421		3,944	3,764	3,225	344,812
1838	1,790	1,553	464		4,018	10,860	2,791	317,245
1840	1,953	1,628			4,251	11,188		
1841	2,118	1,791			4,446	11,738	including the coal trade.	
1842	1,962	1,719		3,803	3,862	10,457		
1843	1,832	1,688		4,734	4,964	7,659	exclusive of the	
1844	2,208	2,174	472	5,360	5,009	8,016	coal trade.	
1845	2,043	2,304	387	5,770	§	8,029	Port Richmond.	
1846	2,289	2,113	459	4,663	6,683	6,018	8,953	1,065,228
1847	3,147	2,734	657	4,864		17,083	11,439	1,375,000

From this view, it is seen that in the greatest increase in the number of foreign arrivals, Boston stands the first, while New York is the second; and on that of coastwise arrivals, if we include the coal trade, Philadelphia considerably outnumbers those of the two other ports. The apparent diminution in the coastwise arrivals at Philadelphia, from 1843 to 1846, is owing to the omission of all the small craft which it had been customary to include. So great are the discrepancies among these statements, that it is impossible to know which to select. There seems no rule observed, by which the actual state can be known through the returns, which can be increased or diminished

* Seybert's Statistical Annals, p. 308.

† Hazard's U. S. Register; Philadelphia Commercial List, and other sources. Commerce of Boston, Hunt's Merch. Mag., Vol. X., 1844.

‡ Commercial List, Jan. 16, 1847.

§ Commerce of Philadelphia—Custom-house returns.

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at pleasure, according to the number of the smaller vessels incorporated therein.

As far as the port of Philadelphia is concerned, the annual returns in the table are exclusive of all ships, barques, brigs, and schooners, in the service of the U. S. government. They are also, with the exceptions marked, entirely independent of the enormous amount of coastwise shipping engaged in the coal trade.* These we have given, where we possess the data.

Statement of the *enrolled and registered tonnage* of New York, Boston, and Philadelphia—employed in the foreign and coasting trade, including temporary registers, and exclusive of the fisheries :† omitting fractions, distinguishing the foreign from the domestic tonnage.

	New York. City and State.		Boston and Massachusetts.		Philadelphia.	
Years.	Foreign Tons Registered.	Coasting Tons Enrolled and licensed.	Foreign Tons Registered.	Coasting Tons Enrolled and licensed.	Foreign Tons Registered.	Coasting Tons Enrolled and licensed.
1793	45,355	13,986	135,599	51,402	60,924	4,579
1800	97,791	51,553	213,197	75,080	95,631	7,380
1805	121,614	67,812	285,689	86,413	77,238	10,016
1810	188,556	83,536	352,806	107,260	109,628	14,255
1815	180,664	100,960	299,298	115,327	77,199	19,875
1820	115,632				59,458	24,117
1825	159,327				65,590	29,421
1830	110,163				47,979	24,236
1835	200,780				51,588	34,857
1840	202,370				52,268	51,676
			Boston only.			
1842	226,072	233,401	157,116	36,385	42,891	57,749
1843	237,240	259,725	165,482	37,116	39,445	64,894
1844	253,888	271,273	175,330	35,554		
1845			194,853	42,146		

1846—tonnage owned by New York, 655,695; by Massachusetts, 541,520; by Pennsylvania, 148,058.

Note.—In commercial navigation, the *registration or enrolment* of ships at the custom-house, is designed to entitle them to be classed among national shipping, and to enjoy the privileges of the country and port, to which they belong, and in which they have been built.

Licenses are granted under certain regulations; among which are their limiting the vessels to certain maximum proportions, and not to be square-rigged vessels, or propelled by steam. These licenses contain an accurate description and admeasurement of the vessel, the names of which may not be changed, and their owners must give security by bond as to the employment of the vessels, which are restricted to the uses assigned.‡

* The returns for these years in the table are from a statistical statement in the U. S. Gazette, Feb. 17, 1847. In Bicknell's Reporter they are thus stated—in 1845, 4620; in 1846, 7046.

† Seybert's Statistical Annals, p. 321—324, and subsequent sources.

‡ McCulloch's Commercial Dictionary.

*Number of Clearances and Entrances of Vessels engaged in General Commerce, for the year ending June 30th, 1847, from the following Ports.**

Clearances.	Number.	Tonnage.	Crew.	Entrances.		Total Number.
				Number.	Tons.	
1. New York,	2,401	758,745	30,247	2,738	853,668	5,139
2. Boston,	2,060	281,874	14,412	2,120	325,426	4,180
5. Philadelphia,	583	143,143	6,155	621	199,774	1,204

Note.—In the scale of importance, of the American ports, New Orleans ranks as No. 3, and Baltimore No. 4.

Steam Engines employed in the Coal business in Schuylkill County,† in 1846.

		No.	Horsepower.
In Pottsville,	previous to 1846,	68	2018
	built in 1846,	23	636
In Minersville and Port Carbon,		15	267
		106	2921
	Employed in 1847,	167	4465

In the valley of the Schuylkill were, in 1847, 324 miles of railroad and 108 miles of canal; in constructing of which have been expended upwards of $19,000,000, while the improvements in railroads and canals, in connection with the transportation of anthracite in the Lehigh Valley, is ascertained at $7,045,000; in other avenues $8,000,000; and in the whole more than $37,000,000.

In justice to individual enterprise, at an early period of the employment of an almost untried combustible, we are bound to note that in January, 1825, Messrs. Jonah and G. Thompson of Philadelphia, completed for their Phœnix Nail-works, on French Creek, a steam engine in which anthracite was employed. We understand this was the first successful application of this fuel to the generation of steam.‡

EMPLOYMENT OF ANTHRACITE IN IRON MAKING.

In the "Revue Generale de l'Architecture," M. Michael Chevalier published in 1840 an account of the anthracite basins of Pennsylvania. His statements contained nothing particularly remarkable, save that they brought down the condition of the operations in coal to a later period than that of Mr. Packer's report in 1833, upon which they are obviously based. He remarked, that the Americans have found out the means of making anthracite available,—not only for manufacturers,—but what was equally novel,

* Official Returns.

† From the Pottsville Mining Journal, Jan. 23, 1847. Also, annual reports of the Pottsville Board of Trade.

‡ Monthly American Journal of Geology, G. W. Featherstonhaugh, Vol. I. p. 72, 1831.

for domestic purposes: so that it has not only *almost* superseded the use of wood in eastern Pennsylvania, but in most towns and cities along the Atlantic shore. New applications of anthracite are discovered, and the Pennsylvania iron masters, in imitation of Mr. Crane, have successfully applied this combustible in their furnaces.

For domestic purposes its use has been greatly aided by the employment of stoves, the adaptation of which to this species of fuel has been advancing, from year to year, in a continued series of improvements, until there is little left to amend or desire.

After enumerating some of the difficulties attendant on its first introduction, and on the acquiring a knowledge of its properties, which were made apparent almost by accident, M. Chevalier adds,—"Mr. Wetherill, one of the principal manufacturers in Philadelphia, showed me in 1835 the place where, twenty years before, he had dug a hole to bury the anthracite, then looked upon as incombustible refuse."*

In relation to the present estimation in which anthracite is held, we may trace its growing importance in exact proportion as, year after year, new methods of application were, almost involuntarily, invented, and as one difficulty after another was surmounted.

Long within the experience of the present writer, large areas of Welsh anthracite land heretofore neglected and commanding only insignificant prices, have acquired a value wholly unexpected. It is no farther back than 1828 that we find Mr. Bakewell, a geologist of no slight eminence in his day, lamenting that the quality of the Welsh coal was "so inferior," and, in fact, so impracticable as to be of little comparative use.†

Let us hear what is now said of this formerly despised combustible, by an intelligent authority writing from the same region:—"Anthracite may be termed a native mineral, containing ninety-four to ninety-six per cent. of carbon; burning without smoke or clinker in the grate, and almost wholly free from sulphur. One hundred tons of this anthracite are equal, in effect, to a hundred and forty-four tons of bituminous coal. Therefore, it enables steam vessels to carry, in the same space, nearly twice the quantity of effective fuel; while the use of anthracite in these vessels lessens the cost of *stoking* five-sixths. The wear and tear of bars, boilers and furnaces, owing to the absence of sulphur, is less. Furnaces of the same dimensions yield, on the average, forty per cent. more iron with anthracite, without any additional cost for labor. Anthracite pig iron is found to possess greater strength and tenacity than any other. In re-melting, the iron runs more fluid, and is very strong—a union of qualities most desirable, but seldom met with; and, owing to the intense and continued heat of anthracite, some of the richest iron ores, not fusible with bituminous coal, are now easily smelted."‡

The rapid progress made in the manufacture of iron in America, by means of Pennsylvania anthracite, since the commencement of the process in 1840, and even during the subsequent years of unexampled prostration in every department of business in this country—especially unpropitious to the introduction of a new branch of manufacturing industry—attest the growing importance of this description of fuel. In this State no less than thirty-six furnaces have been erected during this interval, and several others are reported to be in progress. Those completed yielded in 1845-6, at the rate of 107,200 tons per annum of anthracite iron: being one-third of the

* Revue Generale de l'Architecture, 1840.
† Bakewell's Introduction to Geology, 3d edition, p. 181.
‡ Mining Journal of London, Vol. X. p. 189, 1840.

entire production of pig iron in the United States heretofore. In 1846, the production of 43 anthracite furnaces was estimated at 119,437 tons. To this statement must be added a corresponding proportion of refining, puddling, rolling mills for bar and railroad iron, and other works, in which this fuel is now solely used.*

The Board of Trade of Schuylkill county published the following statement of the number of furnaces and rolling mills in Pennsylvania and New Jersey which employed anthracite as a fuel, and were in operation previously to April 1846: premising that there were only four anthracite furnaces in activity prior to 1842:

	Tons.		Tons.	
42 furnaces, producing of pig iron per week,	2360	or	122,720	annually.
27 rolling mills, manufacturing annually,			114,500	"†

It has been somewhere maintained that coal which yields a *red ash* never works well in blast furnaces, in consequence of the sulphur it contains. It is urged that this sulphur can never be effectually gotten rid of, except by the complete combustion of the coal and of the sulphuret of iron which prevails—the process of coking, whether in ovens or pits, only reducing the *per* to the *pro*-sulphuret. *White ash* coals, it is therefore suggested, should always be selected for blast furnace work, whenever practicable.‡ We conceive that these observations were intended to have reference to the varieties of Welsh bituminous coal in the iron districts, and does not apply to anthracite here. If so, no comment is needed.

In Pennsylvania, the subject of the comparative values of red ash and white ash anthracites used in blast furnaces, has been discussed by practical persons, most of whom conceive that the one is equally advantageous with the other. In one respect the preference is given to the white ash variety, on account of the greater density and compactness of its structure than the red ash coals, which are softer, and are supposed to make a less strong fire. But with respect to the theory that red ash coals contain more sulphur than the white, it has yet to be proved that in an equal average weight of each there is any appreciable difference, taking one coal seam with another.

It is well known that the white ash coals of Pennsylvania contain a larger amount of carbon than the red ash species, and that their specific gravity or density is correspondingly greater. The excess of carbon in the one being balanced by an increase of earthy and ferruginous matter in the other. Yet this excess of earthy matter, containing among other materials a small amount of sulphuret of iron, is very insignificant, and would scarcely produce any perceptible difference in the iron produced by the agency of that variety of coal.

To ascertain the respective amounts of ashes in these two classes of anthracite, we have consulted a variety of tables of analysis of Pennsylvania coals—the results are as follows:

	Per Cent.
Twenty-three analyses of different white ash coals give an average of ashes, - - - - - - -	4.62
Twenty-one analyses of red ash coals in Schuylkill region,	7.29

The red ash has, therefore, only about two and a half per cent. more of

* Letter of the Committee of the Iron and Coal Trade of Pennsylvania.
† Fourteenth Annual Report to the Coal Mining Association, Pottsville, April 1846, p. 9.
‡ Data for the use of blast furnaces, by S. B. Rogers, Nant-y-glo.

earthy matter,—of which portion only eight or ten per cent. consists of iron, —than the white ash.

But what is more directly to the point, is the summary of results of Professor Rogers' analysis of both kinds of anthracite from the Pottsville district, wherein the red ash had absolutely less sulphur than the white.

The introduction of anthracite and the hot blast in the iron-making districts of South Wales, has materially changed the relative proportion of the materials. Formerly, when the bituminous variety was employed in the coke furnaces of Monmouthshire, the materials necessary to make one ton of iron was, as stated by Mr. Rogers of Nant-y-glo, as follows:

Coke, containing 4032 lbs. of carbon,	2 tons or	4480 lbs.
Calcined iron ore, containing 2240 lbs. of iron,	2¼ tons	5040 lbs.
Limestone, - - - 2105 lbs.	1¼ ton	2240 lbs.
Atmospheric air, 360,000 cubical feet about	1¼ ton	2700 lbs.
To make one ton of iron,		14,460 lbs.*

In the United States, the employment of either species of coal and the make of iron from each, will be partly governed by local circumstances, and particularly by the proximity to the main deposits of fuel; while large quantities of iron will, for a long period, be made through the agency of wood. The most rapid advance in iron making, of late years, is in the vicinity of the anthracite districts of Pennsylvania, where, as has been already stated, thirty-six blast furnaces, employing anthracite alone, have been put in operation since the year 1840.

We will endeavour to present an epitome of the iron making of Pennsylvania,—premising that many of these returns are extremely defective.

Years.	Blast furnaces.	Forges & Rolling Mills.	Pig iron made tons.	
1828,	44	78	24,822	Returns much underrated.
1830,	45	84	31,056	
1842,	213	169	151,885	
1843,		"	190,000	
1844,		"	246,000	
1846,	317	"	368,056	

By a pamphlet on this subject published in 1847, by C. G. Childs, there were in the year 1840, by the census returns,—

			Tons.	
Of furnaces, - - - - - -	213	producing	98,395	cast iron.
From the bloomeries, forges, and rolling mills of the State, - - - -	169	"	87,244	bar iron.
Fuel consumed in the process, *chiefly charcoal,* - - - - - -		"	355,903	
Number of workmen employed in all these operations, including mining fuel and ore, - - -			11,522	persons.

PRODUCTION.

The Committee of the Coal and Iron Association of Pennsylvania reported in July, 1846, an estimate of the iron manufacture of this state, from which we derive the following summary:

* Mining Journal of London, 1840, 1841, and subsequently.

	Number.	Tons of iron annually made.
Furnaces operating by the use of charcoal,	274	248,569
Furnaces employing anthracite,	43	119,487
	317	368,056
Increase in the number and production in four years, being at the rate of 142 per cent. in that period.	104	216,171

Capital employed in the production of this amount of pig metal.

		1842	1846
Charcoal furnaces, $47 capital to every ton of pig metal manufactured. Anthracite furnaces, $25 capital to each ton of pig metal manufactured.		$8,560,418	$14,669,818
Increase of capital invested in four years	$6,109,400		
Capital required in the conversion of the pig metal.			
One half the aggregate made, converted into bars, hoops, sheet iron, nails, &c, at $20 the ton,	3,680,560		5,520,740
The other half, into castings, at $10 per ton,	1,840,280		
			$20,190,658

Population employed in this branch of industry.

In mining the anthracite and ore,	4,978 miners
In making the charcoal,	12,428 workmen
Persons dependent on these for their subsistence,	69,624 persons
Population connected with the production of iron,	87,030
Persons deriving support by the labour in the *conversion* of the iron, estimated at a similar number,	87,030
Total	174,060 persons

Without reckoning those who are connected with the manufactories of iron, machinery, &c., or in the transportation and sale of coal and iron, or in the business of railways, canals, &c.

Statement of the supplies of Pennsylvania iron received at Philadelphia from the interior of the state, by canals and railways, during the year 1846.*

	tons of 2240 lbs.
Pig iron and castings	66,568
Wrought iron,	15,588
Blooms,	6,278
Nails and spikes,	4,745
Total	93,179

* Abstract of a table published in the North American, January 2d, 1847.

Statement of the importation of foreign iron into the port of Philadelphia.

		Aver. of 8 years, 1832 to 1839. Tons.	1842	1846
Iron, chiefly railroad iron,	76,132	79,738	3,714	3,575
Steel,	2,276			
Manufactured iron,	1,330			

The recent reduction is attributable to the vast extension of the domestic production.

Gas, as an auxiliary in smelting iron, in Pennsylvania.

The quantity of coal [anthracite] usually required in the iron works, has of late been reduced by the process of heating the blast by the gas from the top; and the steam engine is worked by heat derived from the same source—the boiler being at the top of the furnace.

Wire ropes or cables adopted in mining shafts and on inclined planes, in preference to hempen ropes. See some valuable practical results, under the head of "Prussia;" also in the Journal of the Franklin Institute, of Pennsylvania.

It does not appear that the use of wire cables in the hard anthracite collieries of Schuylkill county, has been altogether successful as a substitute for hempen rope in the "slopes." The difficulty arises from the chafing of the cables, and the clogging of the rollers by fragments of anthracite, which injure the wire cables much more rapidly than it does the hempen ropes.

DELAWARE.

Lignite or Fossil wood occurs in the cretaceous group and green sand formation, and was especially exhibited in the lower mass of strata, in the deep cutting of the Delaware and Chesapeake Canal. Dr. S. G. Morton has adverted to this deposit in his Synopsis of the Organic Remains of the Cretaceous Group. The author observes that, "Lignite at one period was considered to be indicative of tertiary formations, but it is now frequently recognized in the green sand of Europe," and proceeds to point out its existence in similar strata on the Atlantic border of the United States.

Like the strata of this period in various parts of Europe, the lignites here are accompanied by *Amber*, [Succinite.]*

The vast beds of lignite which occupy so much space between the Missouri and the Rocky Mountains, may probably be referred to the supercretaceous period; corresponding with the green sand formation of Delaware, rather than to the tertiary.

* Synopsis, by Dr. S. G. Morton, 1834.

NEW YORK.

PETROLEUM AND SPRINGS OF CARBURETTED HYDROGEN GAS.]

This bituminous substance is commercially known under the name of "Seneca or Genessee Oil," in the town of Cuba, in this state. Mr. Vanuxem described this "oil spring" in his state geological report, in 1837. It is a dirty circular pool, about eighteen feet in diameter, furnishing but an inconsiderable supply of petroleum. The oil is much used by farmers, and has a ready sale.

The reporter observes that, "There is no necessary connection between oil springs and beds of coal; the presence, merely, of bituminous matter disseminated in the rock, accompanied by decomposing pyrites, suffices to account for its presence; or a depth at some former period, sufficient to give the required temperature necessary to disengage the petroleum from bituminous matter."*

On Cayuga Lake also, and at Cataraugus county, in this state, petroleum is found; and in several other localities in York state. Carburetted hydrogen also rises from the water courses in many places. Both of these matters are, in this state, connected with beds of marine shells, and with salt water. So constant, Mr. Vanuxem adds, is the accompaniment of carburetted hydrogen with salt water on the borders of the upper part of the Ohio river, that the presence of this gas is considered a sure indication of the vicinity of salt water.

The details of the number of these "gas springs," are to be found in the chemical reports of Dr. L. C. Beck to the Governor of New York, in 1838.

Fredonia Natural Gas Lights.—Among the most interesting of the cases described by Dr. Beck, is that of Fredonia, in Chautauque county. The gas is collected by means of a shaft, sunk in bituminous slate. It is conveyed by a tube to a gasometer, and from thence, for the purpose of illumination, to different parts of the village. This gasometer had a capacity of about two hundred and twenty cubic feet, and was usually filled in about fifteen hours, affording a sufficient supply of gas for seventy or eighty lights.† For interesting details as to the employment of natural jets of gas, see under the heads of China and Virginia, at Kanawha; also near Pittsburg.

Coal.—The intelligent mineralogist above quoted, reports that, in this state, throughout almost the whole series of its transition rocks, both anthracite and bituminous coal have numerous localities; but invariably in quantities too small for useful or economical purposes. In Europe, this most important fossil substance gradually acquires a maximum, then diminishes to a minimum; passing from plumbago to anthracite, thence to the bituminous, through its various varieties, to the acetous bituminous; thence to fossil wood and peat; and finally terminates in the perfect vegetable.‡

* Mr. Vanuxem's First Annual Geological Report of New York, 1837, p. 195.

† Dr. L. C. Beck's Report in 1838. See also some additional interesting matter under the head of China.

‡ Ibid. p. 196.

Cupriferous Lignites of the Catskill Mountain series.—Vegetable casts, replaced by grey sulphuret and carbonates of copper, occur in the same series of red and grey shales, as we have seen in various parts of Pennsylvania.*

PEAT OR TURF.

Professor W. W. Mather has especially directed attention during the progress of the geological survey, to this substance, both as a manure and a fuel. It is very common, and at some points has been in use for a great many years. A vast number of localities are pointed out in the State Reports, and estimates are made of the amount of peat therein.

As an instance of the value of peat, the case of a bog of 40 acres is cited, which furnishes a supply to the city of New York—where it is sold for $4.50 per cord. The peat being six feet deep, the produce of the sale per acre is $4500, a little more than a third of this being expenses.†

In Mr. Vanuxem's district some valuable deposits of peat are also mentioned.

Dr. Emmons has, in like manner, furnished particulars of peat bogs within his geological district, and pointed out the high economical value which must, sooner or later, attach to this combustible, especially in those countries where coal is absent, or expensive.

"Perhaps it would be saying too much to assert that peat is more valuable than coal; but when we consider that for creating heat it is not very inferior to bituminous coal; that it contains a gaseous matter equal in illuminating power to oil or coal gas; that its production is equally cheap; and in addition to this, that it is a valuable manure if properly prepared, its real and intrinsic worth cannot fall far short of the poorer kinds of coal."‡

Consumption of Fuel in the city of New York (exclusive of foreign coal.)§

Years.	Wood in Loads.	Anthracite and Bituminous Coal. Tons.	Charcoal in Tubs.	Value of Fuel.
1830	297,586	Anthracite, 23,605½ } Virginia, 15,293 }		$814,817
1832	265,192	63,417	347,792	1,327,507
1833				1,127,430
1836				1,100,480
1839	257,676	By canals, 96,431	303,284	
1840	242,944		335,895	2,500,000

Retail annual average prices of Schuylkill Anthracite, broken, per ton of 2000 lbs.

Years.	Average Price.	Years.	Average price.
1838	$8.70	1843	5.96
1839	8.58	1844	5.56
1840	8.00	1845	6.50
1841	8.45	1846	7.00
1842	7.16	1847–8	6.50

* Mather's Fourth Report, p. 229.

† Annual Reports on the Geology of New York, 1838, 1839, 1840. Mather and Vanuxem.

‡ Emmons' Report on the Geology of New York, 1839, p. 216. See notes on Peat, in various parts of this volume.

§ Hazard's Register, 1833 to 1841. This table is incomplete. Also Lehigh Co. Reports.

Wholesale prices by the cargo of Anthracite and Bituminous Coals in New York, the duty $1.75 per ton from* 1832 *to* 1847.

	1832.	1833.	1844.		1845.	1846.	1847.
Quality or Locality.	Per Cargo excl. of duty.		Chaldron.	Per ton of 2240 lbs.	Chaldrons exclusive of duty.		
Liverpool coal per chaldron, - - -	$11.50	$12.50	$8.50 to 9.25	$6.60 to 7.20	$7 to 10	$7 to 8.00	$8.50 to 8.75
Newcastle do.	11.50	12.50	7.00 to 8.00	5.40 to 6.20	6 to 9	6 to 7 00	8.00 to 8.25
Scotch do.			6.50 to 6 75	4.90 to 4.20	6 to 8	6 to 6.50	
Pictou and Sydney do.	9.50	8.50	6.75 to 7.00	4.20 to 5.40	6 to 7	6 to 6.50	6.00 to 6.50
American Anthracite, per ton, 2000 lbs.	9.50	7.50		5.00 to 6.12	5 to 6	6 to 7.00	5.50 to 6.00
Virginia Bituminous, per chaldron, - -	9.00	8.00				6 ts 6 50	Ton.

The retail prices in the years quoted are from $1.00 to $1.25 higher, exclusive of the duty. The chaldron is rated at 36 bushels, and the ton is 2000 lbs. weight.

Population of the city of New York in 1845, 365,000.

Emigrants and passengers arrived:

Years.	Vessels.	Passengers.
1841	2,118	57,337
1846	2,280	115,230

Value of Imports into the port of New York in 1846,	$70,269,811
Value of Exports from the port of New York in 1846,	36,423,762
	$106,693,573

Value of Imports and Exports to and from the port of New York in 1847,† official acccount.

Imports,	$96,447,104
Exports,	53,421,986
	$149,869,090

Cost of the State Canals of New York,‡		$30,987,335
Aggregate of tolls in 1846,	more than 9 per cent.	2,842,214
" " in 1847,	12 per cent.	3,635,330

The average number of days in which the New York canals were navigable, (accidents not included,) in the twenty-three years previously to 1847, viz. from 1824 to 1846, inclusive, was 231.§

There about 1,100 miles of canal and inland navigation in the State.

Capital invested in the railroads of New York, in 1846, $12,750,000.

Aggregate length of twenty-one railroads, in 1847–8, 758 miles then in operation, besides others in progress. Nett income received, about 7 per cent.

Number of locomotives, 107

" of passenger cars, 212 }
" of freight cars, 542 } 893||
" of mail cars, 139 }

* New York Commercial Advertiser, August, 1844.

† New York Evening Post.

‡ Annual Report of the Comptroller, 1846.

§ Hunt's Merchants' Magazine, November, 1847, also January, 1848.

|| American Railroad Journal, Jan. 1, 1847.

The total value of all the property which cleared from and came to the Hudson River, on all the canals, in the following years:

	Boats.	Value of Cargoes.	Tons.
Arrived and cleared in 1844	19,393	$87,782,849	
" " in 1845	20,040	100,906,298	1,428,956
" " in 1846		115,732,780	1,601,535

The value of the entire movement of property, in 1846, from and to the Hudson, is greater by $7,297,845, than the value of all the goods imported into the United States during the fiscal year, ending July 1844; and exceeds by $9,039,207 the aggregate value of the imports and exports of the port of New York, in 1846.

Statement of the *tonnage*, *toll*, and *value*, of articles of all denominations, which passed through the State canals of New York, eastward, to tide water at Albany and Troy.

Years.	Tons.	Toll.	Value at Albany and Troy.
1834	553,596		$13,405,022
1841	774,334	$2,034,882	27,225,322
1842	666,226	1,749,197	22,751,013
1843	834,283	2,081,590	28,376 599
1844	1,019.094	2,446,374	34,183,167
1845	1,204,943	2,646,453	45,452,301
1846	1,362,317	2,842,214	51,105,256
1847	1,744,288	3,635,330	73,092,414

The total value of the exports from the port of New York, in the year 1847, was $2,071,795.

The total amount of tolls upon the New York State canals, received in the twenty-four years, from 1824 to 1847, inclusive, was $34,534,356.

Statement of the number and tonnage of canal boats of every class, which passed upon the canals of the State of New York, in the years 1843 and 1846, showing the comparative increase in the latter, both in number, and capacity, and amount conveyed.

Years.	Number of Boats registered.	Average tonnage.	Aggregate tonnage,	Aggregate of tons conveyed.	Average conveyed by each boat. Tons.
1843	2,126	55	117,553	1,513,439	711
1846	2,725	62	168,287	2,268,662	832

Statement of the quantity and value of mineral coal, chiefly the bituminous coal of Pennsylvania and Ohio, which was transported on the New York and Erie canal, eastward.*

Years.	Shipped at Buffalo from the Lake.	Reached Tide at Albany or Troy, by canal.	Value.	Blossburg Tons.
	Tons of 2240 lbs.	Tons of 2240 lbs.		
1841		8,045	$15,586	
1842		8,816	18,101	
1843		6,528	32,588	
1844		8,250	55,993	
1845	873	21,339	119,496	
1846	1,461	8,414	47,116	
1847		14,055	84,000	30,110

* Annual Report of the Commissioners of the canal fund, Jan. 5, 1846.

The rate of toll on mineral coal was reduced to one mill per 1000 lbs. weight per mile, on the New York and Erie canal, on the 1st August, 1845. As the old rates amount nearly to a prohibition, this reduction secured a revenue to the New York canals, from a source which had previously yielded little or nothing.* The new and old rates are as follows:

	1845	1846
	C. M.	C. M.
Mineral coal, per 1000 lbs. weight per mile, equal to 2¼ miles per ton of 2240 lbs. per mile, - - -	0.4½	0.1
All coal used as fuel in the manufacture of salt, -		Free.

RHODE ISLAND.

LOCALITIES OF COAL.

The report of the Geological Survey of this State, appeared in 1840, from the pen of Dr. C. T. Jackson. This duty, of course, embraced the examination of the Coal formation, the collection of characteristic specimens for analysis, and of organic or vegetable fossil remains; wood engravings of which illustrate the report. Like all the public papers proceeding from this gentleman, it is characterized by special attention to whatever tends to those practical and useful results which constitute essentially the aim and object of his labours.

The two positions where anthracite is found are, 1st, in Cumberland county, north of Providence; and 2d, at Portsmouth, in Rhode Island, 23 miles to the south.

Cumberland.—Only a single bed of anthracite is mentioned here; dipping to the south. All attempts to mine this appear to be abandoned for the present.

Mr. Hitchcock has traced anthracite also at Middleborough, at West Bridgewater, and at Wrexham.

Bristol Neck.—Slate rocks, the grauwacke of the reporter, containing an abundance of fossil plants of the coal period—corresponding with the coal formation on the opposite shore of Portsmouth—occur here, overlying granite; but no coal seam has yet been noticed.

Pappoose.—Squaw's Neck, near Bristol, contains the same series of slates and compact rock, termed grauwacke; and similar vegetable remains as at Portsmouth; but no regular bed of coal is observed.

Cranston.—On *Sockanosset Hill*—strata of similar character, with graphite and impure anthracite, show the extension of the coal formation in this direction.

* Hunt's Merchants' Magazine. Feb. and June, 1846, and other sources.

Warwick Neck.—Similar carbonaceous grauwacke, which is more promising for coal than at most localities, and the local situation is very favourable for mining.

Providence.—From excavations near the Court-house some anthracite was obtained, underlying tertiary clay.*

Newport.—Anthracite beds, a few inches thick, occur in the south part of Newport, in the slate, commonly denominated grauwacke.†

The whole area in Rhode Island State, where rocks of this age appear, covers about 150 square miles. The central part of this is overlaid by horizontal clay and sandy beds, apparently of the tertiary period, but without shells or other fossils.

PORTSMOUTH COAL MEASURES.

Anthracite.—Some instructive details respecting the beds of anthracite and their contiguous rocks, occur in Mr. Hitchcock's Geological report of Massachusetts.

We do not know the date of the first working the coal here, but the operations failed between the years 1809 and 1816, and were subsequently resumed.

Dr. Meade, in Bruce's Mineralogical Journal, January 1820, says that the main seam of anthracite was then in work, and was 14 feet wide; yielding from 10 to 20 chaldrons a day, with the labour of only fifteen workmen. These works were soon after abandoned.

Previously to 1827, the mine was again put in operation, and the quantity of coal raised in that year, by 20 men and 5 boys, was 2200 tons, and an equal quantity of slack or small coal. The former sold at the mine for $4.50 per ton, and the latter for one dollar per ton. The agent, as is usual, represented these beds as capable, in the much hacknied phrase, of furnishing "an inexhaustible supply;" yet we find that, in the succeeding year 1828, the mines were again abandoned, as unprofitable.

Prof. Hitchcock states that "six beds of anthracite are exposed, and more than thirty are said to exist in that part of Rhode Island." The six main seams are probably reducible to three, on each outcrop of the basin; but of the "thirty," we confess ourselves somewhat sceptical.‡

It appears by the reply to a circular addressed by the Secretary of the Treasury for statistical information, that the quantity of anthracite mined in Rhode Island in 1844 was only 2800 tons. The price at the mine has been uniformly $3 per ton; but the mine is since once more abandoned; never having been profitable. §

In 1846, Rhode Island coal imported into Boston, 165 tons.

Mr. Vanuxem was one of the earliest investigators into the quality of the Rhode Island anthracite—in a series of experiments, published in the Journal of the Academy of Natural Sciences in 1825. The result will be found in another part of this work. ||

* Jackson, 1840.
† Hitchcock's Geology, p. 262, 275.
‡ Geology of Massachusetts, 1833, p. 277.
§ Report December 3, 1845, p. 338.
|| Journal of the Acad. Nat. Sci. Phil. Vol. V. p. 17. Experiments on Anthracite, Plumbago, &c., by Lardner Vanuxem, March 15, 1825.

PORTSMOUTH ANTHRACITE FORMATION.

Proceeding now with the State geologist's description,—"The main formation consists of slate rock, which is here and there charged with beds of anthracite. Several small seams of coal have been found as far south as Newport. On Quaker Hill a small coal bed was struck many years ago, but was not wrought. Lawton's valley exhibits the clay slate without any coal beds. Butts' hill, in Portsmouth, presents a mass of stratified rocks, alternating with and overlaying the slates of the coal measures. The strata dip towards each other from each side of this eminence, from Case's coal mine, on the east, to the old Portsmouth mine on the west. In Portsmouth township several seams of anthracite occur, included between beds of carbonaceous slate, subordinate to the fine *grauwacke* rocks. These mines were abandoned by the proprietors, about the year 1825.

The coal beds are stated to be three in number, varying from 2 to 12 feet in thickness, and quite irregular.

The main Portsmouth coal mine is included between walls of slate, and is stated to measure three feet in thickness.

The analysis of the specimens obtained from hence, gave the following results:

First Specimen.		Second.	Third.
Carbon,	84.50	77.00	85.84
Water and volatile matter,	10.00	7.00	10.50
Ashes,	5.50	16.00	5.66

Hence, it is evident that this coal will burn freely.

The anthracite is obtained by blasting, in large masses, and its compactness ensures transportation without waste by fracture.

The best coal is that which is impregnated at its natural joints with peroxide of iron and manganese, (rusty coal,) while the glassy and greyish black masses are more charged with argillaceous (and siliceous) matter, and decrepitate violently when thrown on the fire. Owing to the presence of so large a proportion of water, the coal burns with a flame; the water of composition is decomposed during combustion, and carburetted hydrogen and carbonic oxide are produced. The former gas burns with a yellow, and the latter with a blue flame.

It is evident, from their composition, that the ashes of all these coals will form slags or clinkers.*

The reporter arrived at the conclusion that there is a valuable supply of coal that can be economically obtained at the Portsmouth mines. The opinions formerly entertained as to the difficulty of burning this coal have now no value—for the people of New England did not then understand the art of burning anthracite. A calculation, founded on the supposition that there are three workable seams of three feet each, within the basin of Portsmouth, showed an amount of 37,800,000 tons of coal, available.

The northern and north western portion of the Island of Rhode Island, occupying a space of not less than eight or ten miles long by two wide, essentially form the coal basin of the Island; if we limit the definition to the area which possesses that form of arrangement in its stratification. On the

* Rhode Island Report, 1840.

outer or south-eastern border of this basin, commencing in the centre of the Island, the strata arching over from beneath the coal bearing formation, dip eastwardly. A cursory examination of this basin with some diagrams were made by the present writer in 1841.

GEOLOGICAL CHARACTERS.

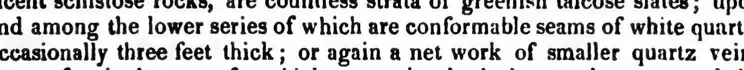
One of the earliest impressions made on the traveller, who, in visiting this region, brings recollections of ordinary coal fields, is the primitive, or rather the metamorphic and disturbed geological character of the entire rock series, much of which is probably new to him under its changed aspect. In fact very few persons, in passing through this region, would conceive themselves in the midst of a coal formation at all.

That we might the sooner attain a correct understanding regarding these novel appearances, some transverse sections were constructed, and also a profile following the east shore of the island. The west coast, being flat and without cliffs, did not well admit of such a mode of illustration.

The first transverse section, crossing from Narraganset Bay on the west by Butts' Hill Fort, to Mount Hope Bay on the east, exhibits an uninterrupted basin-form arrangement of stratification, having coal beds cropping out on opposite margins. Pursuing his inquiry, the geological observer will no longer doubt but the whole group of strata, many hundred feet thick, constitutes an actual coal formation, although its separate members seem to have little resemblance to such rocks as usually comprise our coal fields.

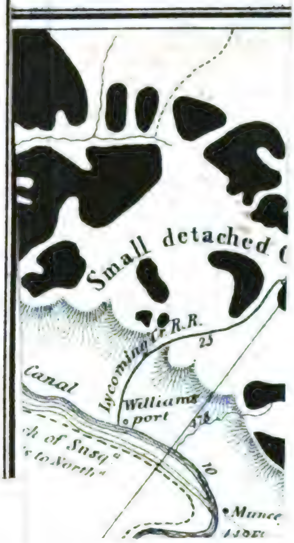
Fig. 16.

Transverse Section of the Portsmouth Anthracite Basin, Rhode Island, looking North.



Based upon more than one mass of very coarse conglomerate, in some positions consisting of large round pebbles of white quartz and fragments of primitive rocks, and in others of oval slaty fragments, formed from subjacent schistose rocks, are countless strata of greenish talcose slates; upon and among the lower series of which are conformable seams of white quartz, occasionally three feet thick; or again a net work of smaller quartz veins from a few inches to a foot thick, traversing both the conglomerate and the talcose slates. Among these slates occur darker laminæ, and these contain distinct impressions of the usual coal plants. Passing from these, the predominant mass consists of talcose schist, among the divisions of which may often be obscurely traced magnificent casts in relief, of ferns, pecopteris, &c. But for these intelligible characters, one might imagine the schists were of much greater geological antiquity.

Following southward along the eastern shore, the cliffs, although not lofty, are sufficiently so, with the aid of the transverse ravines, to develope the structure of the adjacent country. In the course of two miles of the cliffs of the east coast, the conglomerate beds are six times thrown up, and as often descend below the tide level. Then occur a numerous suite of twisted and contorted schists, of grey laminated slates whose surfaces singularly resemble the grain of birds-eye maple; and again another series of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green, talcose, contorted schists, crowded with crystals of iron pyrites; crossed in every direction by innumerable veins of white quartz, and succeeded by compacter beds which almost possess the qualities of sandstone. Perpendicular upthrows and heaves, and again the reverse movements, divide the whole series into large and separate sections, rising above or sinking below, water level. The inclination of the respective masses is continually changing. To the rocks we have enumerated succeed a *melange* of metamorphic slates, of grey fissile beds, of conglomerates, quartz veins, and black shales; of veins and filons of asbestos, and of talcose laminated strata; undulating, fractured, contorted, inverted—in short, disposed with such absence of order and arrangement, as to defy the pen and pencil of the geologist to delineate.

Leaving the coast line at Clark's Mill and Creek, our *second transverse section*, of 3½ miles, crosses over to the opposite or western shore. During half this space, the metamorphic rocks alone, to which we have alluded, and which are named *Grauwacke* in the state report, appear on the surface and dip to the eastward. The schists and coarse slates, the carboniferous shales, and the quartz veins, which here seem to be appropriate to the coal-bearing series, are again seen arranged in the basin form, stretching to the coast near Lawton's Valley. We only observed one bed of anthracite, whose immediate out-crop exhibited about 1½ foot thick, increasing as it descended. How far to the south this trough extends we did not attempt to trace; but as thin seams of coal are seen among the modified rocks, on the coast east of Newport, it is probable this arrangement continues through the entire length of the island.

Returning to our first transverse section of the coal basin, near the parallel of the Portsmouth mines. Certainly, there are many features here presenting themselves that have no parallel in our ordinary secondary coal fields. Among these are the vast assemblage of talcose, waving slates; the veins and seams of asbestos, abundant even among the coal shales, and occasionally penetrating the anthracite itself; the quartz veins also in the coal; the unusual appearance of vegetable remains on these greenish-grey, schistose laminæ; the traversing veins of white crystalline quartz, and the plumbaginous nature of nearly all the out-crops of coal. All these characters might readily lead geologists to ally the series to the transition or primary rocks.

Details of the Coal Beds.—Yet perhaps these are entirely due to the metamorphic influence to which the whole group, in common with all others in the surrounding country, has been subjected. There are three coal seams proved on the western side, occurring at the distance of ninety feet from each other, and dipping, at an angle of 38° to the centre, but probably flattening in that direction. Towards their out-crops all the strata evince the effects of great pressure and squeezing; producing corresponding irregularities in the thickness of the coal beds, such as will probably always render the working or productive results uncertain.

In some particulars there appear to be analogies between the talcose schists and accompanying beds of anthracite in Rhode Island, and the anthracite seams associated with strata of gneiss and talcose schists, formerly considered as primitive, at L'Oisans, in Dauphiny, and the Alps. M. A. Brongniart has declared that the coal vegetation of this formation is identical with that of the true coal measures. M. S. Gras confirms this view, and states further that these were sedimentary rocks, modified by subterranean emanations. In the Alps there are many proofs of the transformation of sedimentary into crystalline rocks, as high up as the coal measures.

The old Portsmouth Mines, towards the close of 1841, had been re-opened, and several new shafts had been commenced in their vicinity. As regards facilities of transportation, no position can be more convenient; for sloops and schooners can approach within one or two hundred yards of the mine. The quality of the coal is excellent; the demand for it increases every year, and it can readily be sold, as fast as it is possible to mine it. In 1842, the price for the large coal was $5.00 per ton, and half that sum for the finest or pea coal: terms which can be commanded nowhere else at the pit's mouth, in the United States. As a proof of the value even the smallest had acquired, the owners were screening over the refuse heaps, abandoned 20 years before; and were selling the coarsest at $2 to $3 per ton; the next size at $1.25, and mere dust 75 to 50 cts. The quality of the coal improves as the depth increases. As may be inferred from the geological condition of this region, the great drawback on the prospective value of coal undertakings any where within its limits, and on the confidence so essential to such operations, arises from the irregularity of the ground; making the thickness and the continuity of any one coal seam, a matter of extreme uncertainty, even for the space of a few feet. The roof of the main worked bed is tolerably regular, and consists of a good hard slate; but the floor undulates considerably, and of course affects the thickness of coal to a corresponding extent. At one point here there were only eighteen inches of coal, between roof and floor; yet on advancing but a short distance we observed a thickness of fifteen or sixteen feet. Under these circumstances, it is difficult to assume an average. Dr. Jackson's estimate of three feet workable coal to each seam, through the entire basin, may be a safe one, but we would not like to be the purchasers on the basis of that calculation. In 1842, the slope or inclined plane of the main gangway down the crop of the vein, was three hundred feet. Lateral drifts, following the coal seam, showed about three yards thickness; but we subsequently learned that it had again contracted.

The seam lying above this had been commenced by other owners, as a colliery, in 1841. Its thickness was then six feet; both roof and floor were good and promising, being of clay slate, dark, tough, and regular. Many coal plants occur in the roof.

The plumbaginous character of the carbonaceous deposits throughout the entire range from Mansfield in Massachusetts to Newport in Rhode Island,* is not devoid of interest, either to the miner or the mineralogist. At Wrentham in Massachusetts are several seams of highly plumbaginous coal.† At Mansfield also, Dr. Jackson mentions a bed of coal which "*was found to have been altered, and was like graphite or plumbago.*" In Rhode Island the presence of graphite is not adverted to by the state geologist, further than to remark in his analysis, No. 2, of the Portsmouth coal, that it was *not* plumbaginous. At some new trial openings in the latter neighbourhood, on more than one outcrop, we observed that the mineral appeared to consist almost wholly of graphite. It is remarkably light, spongy, or cellular—and is collected and forms an article of sale at a good price, under the name of "British Lustre," for the usual purposes of plumbago or black lead. Asbestos occurs abundantly, running through the slates which adjoin the coal or graphite bed. Like those of Massachusetts, they are also traversed, and even the coal itself, occasionally, by numerous veins of quartz. All these circumstances combine to satisfy the most skeptical, of the modified or metamorphic character of the coal field of Rhode Island.

* Geological Survey of Massachusetts, p. 162, 1833.
† Hitchcock's Geology of Massachusetts, p. 46.

Viewing it in this light, there seems to be no assignable reason why this formation, in which we trace the fossil flora of the regular coal measures, should be considered any older than the secondary anthracites and bituminous coals of Pennsylvania; and we are sustained in this opinion by the declaration of Dr. Macculloch, that, "the coal of secondary origin, containing vegetable remains, is converted into plumbago by the influence of trap, as coal is, daily, in the iron furnaces."*

It is well known, that, until within a comparatively recent period, the beds in which numerous seams of anthracite occur, in Ireland, were confidently termed by distinguished geologists, "transition clay slate, intermixed with considerable beds of quartz." Yet it is now universally admitted that the entire coal field is of no older date than the regular bituminous coal fields elsewhere.

Even the western part of the South Wales coal basin, was at one time called the "Grauwacke series."

Since the foregoing notes were collected, we have been favoured by Dr. Emmons with his volume on the so-called Taconic system, as exemplified in the northern states of the Union; including the Rhode Island coal-fields. The Taconic system, according to the views of the author, and in opposition to those of many eminent geologists, embraces a series of rocks which are supposed to be older than the New York lowest series, and are characterized by a separate class of organic remains. It rests unconformably upon primary schists.

We believe that the author does not comprise within this system the coal formations of Rhode Island, although they repose upon it, and have many lithological characters in common, on account of the proximity of the schistose Taconic rocks which have furnished the greater part of the materials; and consequently they appear to possess a character of much greater antiquity than the coal and subjacent rocks usually exhibit elsewhere.

"That it is possible for a sedimentary rock to retain or assume the characters of the parent rock, is rendered highly probable by the characters of the rocks or slates connected with the Rhode Island coal beds. Here, in connection with the conglomerate, probably of the old red sandstone, there is much material which is a talcose slate, differing but slightly from the talcose slate of the Taconic system. The beds of conglomerate with which these slate beds are in connection, do not appear to be metamorphic; and the whole seems to be merely indurated or hardened slate, the original particles being talc and mica, with some fine quartz. The rock, when complete, is merely an ordinary talcose slate."

Dr. Emmons is somewhat indisposed to admit the metamorphic character of the Rhode Island coal, inasmuch as the slates and conglomerate bear no marks of the action of heat; the fossils are similar in texture to those of other coal-fields, and are free from all traces of fusion; and because if sufficient heat had been applied to volatilize the bitumen of the coal, then ought the slate also to exhibit marks of having been burnt. These reasons, however, do not appear sufficiently conclusive, nor do they apply to the anthracites of Pennsylvania, which exhibit no traces of fusion, neither in the coal, the slates, nor the organic remains. I believe the word "*baked*" has been frequently applied to this process, and with apparent propriety. Dr. Emmons admits that this coal of Rhode Island is traversed by veins of quartz, which might have been deposited from hot water or aqueous vapour holding

* System of Geology, Vol. II. p. 297.

silex in solution. The changing of the coal into graphite still remains to be accounted for.

As relates to the economical value of this anthracite.—On the whole, we see no reason for dissenting from the prediction of Mr. Hitchcock, "that, ere long, the anthracite of Rhode Island, and even that of Worcester, will be considered by posterity, if not by the present generation, as a treasure of great value."

It is objected to this coal, that it will not succeed in an open grate, and that the cold air chills the fire in that position; but that it answers well when consumed in cylinder stoves. The only objection urged in that case, is, that it occasionally forms too much clinker. If we look at the numerous analyses of this coal, and see the small amount of foreign matter which it contains, besides pure carbon, we certainly should not expect such a result.

Quantity of Pennsylvania anthracite imported into Providence:

1844, - - -	51,848 tons.
1845, - - - -	67,638 "

An annually increasing quantity of Nova Scotia coal is also brought into Providence.

ANTHRACITE NEAR PAWTUXET.

An announcement was made, in 1846, of a new locality of anthracite in this state, near the Valley Falls. Subsequently, a mining company has been carrying on some operations here, and report speaks favourably, thus far, of the success of the undertaking, and of the quality of the coal, except in regard to hardness. A depth of one hundred and twenty feet has been sunk, and about five hundred tons of the anthracite were raised in the summer of 1847. The mine is about six miles south of Providence, two from Pawtuxet, and not more than two miles from tide water.

PEAT.

Block Island.—The most southern appendage to this state, and included in Dr. Jackson's geological and agricultural survey, in 1840—from whence we obtain the substance of the following details.

"*There are no trees upon Block Island,* and since wood fuel is too expensive for general use, it most fortunately happens that nature has amply provided the inhabitants with a great and almost inexhaustible supply of *peat*, or *tug*, as it is there called. Thus, almost every family owns a peat bog, which is their depository of fuel, from which they draw an ample allowance, yearly.

"Attached to every dwelling we find a '*tug-house*,' in which is stored up the winter's fuel; and each family burns from twenty-five to thirty-five cords of peat per annum. The mode of preparing it is—in case it is a first cutting—to split out cakes of it, about six inches square, which are laid upon the bank to dry in part; after which it is turned; and subsequently it is piled up, in open stacks, through which the air circulates and completes the process.

"In case an old bog is dug over the second time, *the peat is made by the hands into balls*, as large as a twelve-pound cannon shot; and these are laid on the ground partially dried, and then stacked, like piles of cannon-balls. They become firm, and burn very well; giving out a large and clear flame, and making a good coal. The fire-places are all arranged with peat grates,

or frames made of bar-iron, large enough to fill a kitchen fire-place. On this they lay the peat, and it proves to be an excellent fuel; giving a good clear fire, suitable for all kinds of cooking, and for the warming of apartments.

"I think that most persons would give up their prejudices against peat, if they should spend a few weeks among the people of this island."

The opinion prevails that when *tug-bogs* have been entirely cut out, by throwing back the loose turf, the peat grows again in forty years, so as to fill the bogs.

Every little valley on Block Island contains a few acres of turf bog; and its depth varies from four to ten feet. There is evidently enough left, even if it does not grow, to supply the inhabitants with fuel for ages.

At a great number of points in this state, peat bogs prevail. Besides as fuel, it is used as a valuable ingredient in composts or manures. By analysis, it was found to yield 88 per cent. of vegetable matter, and 12 per cent. of ashes.

Some peat from another part of the state gave 88.6 vegetable matter, 9.5 of silex, and 1.9 of various substances.

Another contained 95.5 per cent. of vegetable matter. To these are added, in the appendix, the analysis of twenty specimens of peat from various parts of the state.

This substance is held in high estimation in New England. In the Farm Reports of Rhode Island, Mr. Phinney, addressing the State Geologist, says, "I know of no way in which you could render a more essential service to the public, more especially to farmers, than by enabling them to convert their unproductive and unsightly bogs into sources of wealth. I consider my peat grounds by far the most valuable part of my farm; *more valuable than my wood lots for fuel,* and more than double the value of an equal number of acres of my uplands, for the purposes of cultivation. In the first place, they are valuable as fuel. I have for twenty years resorted to my peat meadows for fuel. It gives a summer-like atmosphere, and lights a room better than a wood fire. The smoke from peat has no irritating effect upon the eyes; it does not, in the least degree, obstruct respiration, like the smoke of wood; and it has none of that drying, unpleasant effect of a coal fire. Peat, taken from land which has been many years drained, when dried, *is nearly as heavy as oak wood, and bears about the same price in the market.*"*

* Rhode Island Report, p. 247.

MASSACHUSETTS.

MANSFIELD ANTHRACITE MINES, FIFTEEN MILES NORTH-EAST OF PROVIDENCE.

Dr. Jackson examined this coal for the sake of comparing it with that of Portsmouth.

The result of an analysis of a fair sample, was

Carbon,	87.40
Water, and volatile matter,	6.20
Ashes,	6.40

It appears on this authority, that a small seam of anthracite was accidentally discovered in Mansfield, in 1835, in the process of sinking a well. In consequence of this, numerous persons obtained leases with the right of mining, on farms in this vicinity. The first vein was only eighteen inches thick, and was not worked, on account of being so small. Subsequently, the researches conducted under the direction of Dr. Jackson, determined the existence of five beds of anthracite, the maximum thickness being five feet; and their apparent linear extent was not less than one mile.

These beds abounded in coal plants, of which many species were collected by the geologist.

Several analyses were made to determine the character of this anthracite, which seems to differ from that of Portsmouth, chiefly in having a greater amount of carbon, viz., 87, 90, 92, 96, and 98 per cent., with a reduced quantity of ashes.

From want of experience in mining, the adventurers failed to derive an adequate benefit, and the mines were abandoned in 1838.

They were re-examined, in 1839, by Dr. Jackson. One seam was proved to be seven feet thick, and its quality was good,—yielding but six per cent. of ashes.

At another mine, where a shaft had been sunk to the depth of one hundred feet, a bed of coal was encountered, but thought to be inferior.

The nature of these seams seems to correspond, as regards irregularity, with most of those known in Rhode Island. Some days the miners raised ten tons of coal, while on others they obtained but little;—yet the geologist considers that the Mansfield coal mines are still capable of being worked to good profit, if pursued with skill and judgment.*

The usual coal plants occur imbedded in the shale and slate of the Mansfield district: but, Mr. Lyell observes, no traces of shells or corals have been discovered.

"In like manner, we find an absence of all fossils, except vegetable remains, in the anthracite coal district of Pennsylvania, and no fossils of any kind in the subjacent conglomerates and red sandstones."† In the bituminous coal shales of Pennsylvania, we, however, find several genera and species

* Dr. Jackson, on the Mansfield Coal Mines, in his Rhode Island Report, in 1840.

† Quarterly Journal Geol. Soc., London, No. 1, p. 201.

of fossil shells, and the remains of fishes and shells in the sandstone beneath. At Blossburg, numerous shells occur in the coal and iron shales.*

Plumbago. In all the cases which we have cited, respecting the anthracites of Rhode Island and Massachusetts, it would appear, in accordance with the views of Professor Hitchcock, that there exists, in these regions, a gradual passage from anthracite to plumbago, or graphite. Whether this approach to graphite arises, according to the view of the learned professor, from the *age* of the enclosing rocks, or whether it be not rather the result of the obvious modifying influence of igneous operations, as we have suggested, we will not now discuss.

Import of Pennsylvania anthracite, and of American and Foreign bituminous coals, reduced to the common denomination of tons, from chaldrons, tons, and bushels, into the port of Boston. Note—there are considerable variations in the published statements of coal imported and consumed in Boston, which cannot be readily accounted for.

American Coals.			Foreign imported Bituminous.			
Years.	Anthracite tons of 2240 lbs.—chiefly from Philadelphia.	Richmond and Pennsylvania bituminous coal. Tons reduced from bushels of 80 lbs and from chaldrons of 36 bushels.	Scotch and English in tons from chaldrons of 36 bushels or 2800 lbs. reduced to tons of 2240 lbs.	Nova Scotia and Cape Breton from chaldrons of 1¼ tons or 2800 lbs.	Total of British and Colonial tons.	Total consumption of all kinds in tons.
1834	76,180	4,504			25,513	106,197
1835	75,722	7,575	4,287	17,650	21,937	105,234
1836	67,186	7,165	9,146	30,453	39,599	113,950
1837	80,557	3,903	11,873	37,114	48,987	138,447
1838	71,364	3,843	10,344	33,262	43,606	128,813
1839	90,485	5,160	5,880	47,482	53,362	149,907
1840	73,847	3,299	12,410	37,587	49,997	127,143
1841	110,938	4,430	14,245	37,536	51,781	167,149
1842	90,276	4,350	12,718	27,374	40,092	134,718
1843	117,451	5,354	6,862	25,230	32,092	154,897
1844	139,566	6,103	9,098	25,417	34,515	180,184
1845	165,422	10,160	15,195	42,035	57,230	232,812
1846	168,001	6,179	13,188	26,851	40,039	214,219
1847	258,093	4,554			65,203	327,850

The retail chaldron of Boston is from 2500 lbs. to 2700 lbs. weight.

Virginia coal is sold in Boston, chiefly for glass-houses; and, otherwise, the quantity does not affect the retail trade. This coal was purchased, in 1845–8, for from $7.50 to $10.50 per chaldron.

Annual Importation of Virginia Coal into Boston.			
Years.	Bushels.	Years.	Bushels.
1835	212,105	1839	144,475
1836	200,635	1841	124,041
1837	109,275	1843	149,996
1838	107,625	1846	6,584 tons.

* Also abundant shells in the coal shale at the Portage Railroad. See Trans. Geol. Soc. Penn. p. 255.

Statement of the quantities and value of American and foreign coal consumed in manufacturing, in the State of Massachusetts, during the year ending, April, 1845.

		Tons.	Value.
	Anthracite, - -	79,749	$453,411
Bituminous coal	American, - -	21,948	147,917
	Foreign, - -	29,578	190,405
		131,275	$791,733

Average retail prices of anthracite and bituminous Coal into Boston.

	American Anthracite, per ton of 2000 lbs.					Foreign Bituminous Coals, per chaldron.			
			Schuy'll.						
Year.	Lehigh.	Lackawanna	White ash.	Red ash.	Bituminous Richmond, per chaldron.	Cannel.	Liverpool and Scotch and Newcastle.	Picton.	Sydney.
	Dollars.	Dol.	Dol.	Dol	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.
1841	8.87	8.75	8.75	9.21		12.42	10.92	9.25	9.25
1842	7.21	6.96	6.96	7.58		10.75	9.41	8.33	9 25
1843	5.75	5.75	5.75	7.08		12.50	10.08	8.58	8.58
1845	6.00	6.00	6.25	6.25	7.50 to 10.50	9.50	7.50	6.75	7.25
1846							8.00 to 10.00	7.50 to 9.00	8.50 to 9.50
1847	6.75	6.75	6.75	7.00	7.00 to 10 00	11.00 to 12.00	10.00	8.25 to 8:50	8.50
1848	6.50 to 6.75		6.75	7.00	6.75 to 7.00	11.00 to 11.50		7 25 to 7.75	7.75

Wrentham Coal explorations, five miles from Mansfield.

These were visited by Dr. Jackson in 1839 and 1840. Although some seams of anthracite existed here, they were adjudged to be too thin to warrant the expenditure attending their mining.

They are also noticed by Mr. Hitchcock, who states that the coal bears a resemblance to the anthracite of Rhode Island.

From the carbonaceous and pyritiferous slates of this impure coal, Mr. Lyell collected numerous impressions of the most common coal plants. Like those of Rhode Island, the slates and micaceous sandstones forming the roof of this anthracite, contain layers and veins of quartz.

Worcester.

Plumbaginous anthracite, according to the state geologist, occurs in an imperfect mica slate, or transition mica slate. This coal bed is seven feet thick, dipping moderately to the north-east; but the works were suspended in 1833.

In this coal, he observes, the metallic aspect is even much more distinct than in the Rhode Island coal; and the quantity of the plumbago is much greater. Several tons of this substançe have been ground, and sold for plumbago.*

The Rhode Island coal is heavier than the purest Pennsylvania anthracite, and that of Worcester is heavier than the former, as approaching nearer to graphite.

We subjoin the specific gravities of these, determined by well known authorities; remarking, however, that its great weight seems mainly to be

* Hitchcock's Geology of Massachusetts, p. 279.

the result of a superabundance of earthy matter, as shown by Dr. Percy's analysis.

Purest anthracite of Lehigh, broad Mountain, &c., (Bache, Johnson and others,)	1.600 to 1.650
Massachusetts. Mansfield plumbaginous anthracite, (Dr. Jackson,)	1.710
Portsmouth, R. I. Plumbaginous anthracite, (Dr. Jackson,)	1.770 to 1.850
Worcester. Plumbaginous anthracite, (Bull,)	2.104 but doubtful
Graphite. (Dr. Ure and Beudant,)	2.080 to 2.450

This plumbaginous anthracite has lately been submitted to the examination of Dr. John Percy, of Birmingham, England. The following result is published in the proceedings of the Geological Society of London.*

Carbon,	28.350
Hydrogen,	0.926
Oxygen, Nitrogen,	2.155
Ashes,	68.569
	100.000

Mr. Lyell is of opinion that the stratified rocks, containing the plumbaginous anthracite of Worcester, consisted originally of sedimentary strata, which have been so altered by heat and other plutonic causes, as to assume a crystalline and metamorphic texture, by which the grits and shales of the coal have been turned into quartzite, clay-slate, and mica-schist; and the anthracite into that state of carbon which is called plumbago or graphite.†

The quantity of anthracite annually produced in Massachusetts is but small. We see by a late report, that the value of the mineral coal and iron ore obtained in 1845, was together, but of the value of $21,669.‡

Dr. C. U. Shepard remarks, that the discovery of anthracite at Worcester, in this state, unattended with any secondary or recomposed rocks and vegetable remains, is an apparent exception to the general rule that, "Good workable coal has never been found either in the oldest crystalline rocks, or in the newest formations of the secondary." We think this anomaly is explainable on the ground of the great change in structure and appearance of the regular coal series, and the local effect of intense heat, and consequent modification of character to which the mass has evidently been subjected.

It may even be questioned, however, he adds, whether this seam of plumbaginous mica slate, deserves the name of coal slate.

Production. 1844–5, mineral coal and iron ore mined, 21,669 tons—78 hands employed.§

Bituminous Coal in new red sandstone.

The State geologist observed "thin veins and irregular nodules" of coal in the new red sandstone of the Connecticut valley; but as it is acknowledged that "in almost every instance it appears to be the result of the carbonization of a single plant, whose form can be distinctly traced," we have small

* Quarterly Journal of the Geol. Soc. No. 2, p. 205.
† Lyell on Massachusetts Anthracite, Ibid. p. 199, May 1845.
‡ Statistics of Massachusetts, by John G. Palfrey, Secretary of the Commonwealth, 1846.
§ Hunt's Merchants' Magazine, Vol. XIV. p. 285.

expectation that workable beds of coal will ever be met with here, any more than in other parts of the globe, in the same geological formation. It is also to be noted that in some parts of the range, these coal traces have been deprived of their bitumen, and have the character of anthracites. This is explained by the author, by the accidental presence or vicinity of trap rocks.*

Railroads, completed in 1846, six principal roads—381 miles.

CONNECTICUT.

Coal has not been found in this State in sufficient abundance to be ranked with its valuable mineral productions. Dr. C. U. Shepard, reporting on the Geological Survey of Connecticut, announces this fact. Some effort had been made to obtain coal in a highly glazed, plumbaginous mica slate at Sandy Hook near Newtown; but the result was unsuccessful and the geologist recommended the abandonment of the enterprise, without delay.†

The State geologist of Massachusetts mentions some thin veins of bituminous coal in the new red sandstone of the Connecticut valley.‡ So late as November 1847, it was announced that a bed of coal had been discovered in the town of Ridgefield, and that measures were in progress for working it.

* Geology of Massachusetts, 1833, p. 230.
† Geological Survey of Connecticut, Report 1837.
‡ Geol. Report of Massachusetts.

NEW HAMPSHIRE.

No traces of coal rewarded the researches of the State geologist in 1840 and 1841, and it appears, from his report, that there is little probability of any being found.

He points out the peculiar applicability of the science of *modelling*, to this interesting and picturesque area.*

Peat.—This useful substance is beginning to be understood and appreciated in New Hampshire; a recent notice, [1844,] informs us, that in the vicinity of Piscataguog village, a piece of swampy land, which was thought of but little value, was purchased for a small consideration.

The proprietor afterwards discovered that it was covered with *Peat*, to the depth of from three to six feet, and contained one thousand cords to the acre, which are valued at about two dollars per cord.†

The analysis of New Hampshire Peat, by Messrs. Whitney and Williams, is as follows:

Locality.	Vegetable matter.	Silica, alumina, Iron and Lime.
Meredith,	94.90	5.10
Canterbury,	93.80	6.20
Franconia,	73.70	26.30

Peat is employed as an important ingredient in forming a compost for agricultural purposes, in New Hampshire.

MAINE.

Anthracite and Bituminous Coal.—Although in his "Report on the Geology of the Public Lands" in this state, Dr. Jackson, we believe, did not obtain actual evidence of beds of coal, yet he announces the presence, at various places, of the formation in which coal is usually found, elsewhere, and we have good reason to hope that, when explorations for that object can be more leisurely undertaken, we shall be enabled to add Maine to the other coal producing States of America.

All along the south side of the Aroostook, and stretching southward of Mars Hill, over an area of 120 to 150 square miles; and north of the Aroostook, over an undefined area as far as Temiscouata Lake, are seen, according to the geologist, "all the marked characteristics of the regular anthracite coal formation."‡ The rocks certainly belong to that formation, and are

* Geological Report of New Hampshire, by C. T. Jackson, 1841, p. 54, 161.
† Manchester Memorial, August, 1844.
‡ Geology of Maine.

frequently glazed with carbon, but no bed of coal was discoverable. This is not by any means a decisive or even discouraging circumstance; when it is remembered how unfavourable to such discoveries is the position of the surveyor whilst passing, amidst numberless privations and difficulties, through an almost impracticable and uninhabited wilderness. Accident will probably bring to light, much that must inevitably escape the scrutiny of the most practised observer.

As the "regular coal series" is mentioned, in conjunction with "the old red sandstone, resting upon the grauwacke," we should infer that the coal, if any, belongs precisely to the same age as the great central coal-fields of the United States, whether bituminous or modified in the form of anthracite.

Shales, containing vegetable impressions such as usually characterize the coal measures, have been observed at Waterville and certain points in this state; but the geologist hesitates to vouch for the absolute existence of coal.* These supposed impressions, indicative of the coal measures, have been decided by Prof. Hubbard and admitted by Dr. Jackson, to be not vegetables, but true annellides, such as characterize the slates which Murchison has included in the Cambrian series.†

Peat.—Dr. Jackson, than whom there can be no better authority on agricultural geology, directed his attention to the numerous valuable deposits or rather accumulations of peat, in this state. At the localities which he designates, this substitute may be most advantageously wrought for fuel: it is applicable to the burning of lime, and various domestic uses, as well as convertible into a powerful manure, admirably adapted for loosening and enriching clayey soils.

By an extract from a report ascribed to this author, and quoted in Silliman's Journal, we learn that in Maine, peat is found at the depth of three feet from the surface, amid the remains of rotten logs and beaver sticks; showing that it belongs to the recent epoch. The peat is twenty feet deep (thick) and rests upon white siliceous sand. This recent coal was found while digging a ditch to drain a portion of the bog.

"On examination I found that it was formed from the bark of some tree allied to the American Fir, the structure of which may be readily discovered by polishing sections of the coal, so that they may be examined by the microscope."

Dr. Jackson's analysis, shows that it contains, in 100 grains,

Bitumen,	72
Carbon,	21
Oxide of Iron,	4
Silica,	1
Ox. Manganese,	2
	100

"This substance is, therefore, a true bituminous coal, remarkable indeed for containing more bitumen than is found in any other coal known. I suppose it to have been formed by the chemical changes, supervening upon fir balsam, during its long immersion in the humid peat." This is a very interesting discovery; and the same substance appears to exist in other peat bogs of the State.‡ See notices on Peat in other parts of this volume.

* First Report on the Geology of Maine, p. 106.
† Proceedings of Assoc. of American Geologists, 1841.
‡ Silliman's American Journal of Science.

In his "Report on the Geology of Maine," in 1837, the author last quoted notices the accumulation of Peat at Quoddy Head, near the south-east angle of the State. This mass is 15 feet thick, and it is suggested to deprive it of its water, by means of pressure, when it will form a valuable fuel. When it is remembered that, according to the analysis of Sir Humphry Davy, peat contains 60 per cent. of carbon, its use should by no means be discarded. It is a valuable fuel for domestic purposes and for many manufactories.

The above remarks will apply to many other localities in Maine, and the time will arrive when, wood becoming scarce, our neglected peat bogs will be in requisition.* In Germany, peat is dried in kilns, heated with the small fragments and the refuse parts of the same substance.

See under the head of Peat and Turf, in various parts of this work. We have in our introductory portion of this work, explained the mode of working the turbaries or peat bogs of France.

MICHIGAN.

BITUMINOUS CENTRAL COAL BASIN, BETWEEN LAKES HURON AND MICHIGAN.

To the series of reports made annually by Dr. Douglas Houghton and his assistants, we are indebted for the earliest notice of this coal-field.

This able geologist was appointed to commence the survey of the State in 1837, and, in the execution of duties unusually arduous and fatiguing, exhibited much zeal and perseverance.† His reports, however, up to the present time, have not received the elucidation they so much need, from geological maps of the State.

In a region which almost every where is thickly covered with beds of diluvium, sand and tertiary clay, which for by far the greater part remains even now in its original state of primeval forest, and which, except as relates to the superficial value of the soil and timber, continues uninvestigated, it would be unreasonable to expect from the geologist much exactness of detail, as regards this important coal-field. We are yet in uncertainty as to its limits, for no part of it, strictly speaking, can be said to be satisfactorily defined. The few coal strata which exist have so little inclination, and are so completely buried beneath the more recent deposits referred to, that positions where outcrops can be observed are of rare occurrence, and these are only found along the beds of the rivers, with which this beautiful country is thickly intersected. The northern termination of the formation, of which the coal seams form an important member, is left entirely conjectural, but

* First Report on the Geology of the State of Maine, by Dr. C. T. Jackson, p. 32.

† Since penning the above passage, the unfortunate death of this talented man has come to our knowledge. He was drowned during a sudden snow storm, on Lake Superior, while engaged in his professional duty.

is supposed to reach the head waters of the Tittabawassee and Maskego rivers. This part of the State was, at the time of the survey, entirely an uninhabited region.

Dr. Houghton came to the conclusion that the coal-bearing sandstones, or, strictly speaking, the *coal basin*, occupies an extent of surface nearly oval in form, whose centre very nearly corresponds with the true centre of the peninsula.

He estimated this area at 150 miles in length, from south to north, and upwards of 100 in extreme breadth—covering an area of about 11,000 square miles. The general outline, as sketched by this geologist, is probably approximately accurate: fully as much so as the nature of the country permitted in 1840.

How much of this area may be considered an actual coal-field, is matter of conjecture, of course. From a consideration of the map of the State, and from a partial reconnoissance of the district, by the present writer, in 1847, we think it a safe calculation to estimate the productive coal-bearing area at 100 miles in length, by an average breadth of 50 miles. This may be computed at 3,000,000 acres, or somewhat less than 5000 square miles.

The coal seams are thin and few in number. What are usaally denominated the coal measures are comprised within a very limited thickness. The entire coal-field is evidently a shallow one, having suffered little from disturbance.

Dr. Houghton's section exhibits the coal series, as consisting of two beds of coal and bituminous shale, separated by a bed of undetermined, but inconsiderable, thickness of sandstone; the whole group resting upon a grey fossiliferous limestone, which does not anywhere exceed 14 feet in thickness.

UPPER COAL FORMATION.

Maximum thickness 30 feet,—of comparatively small area, in the central part of the coal basin. The coal is comprised in several layers, not exceeding in thickness from one to two feet each, accompanied by thin beds of argillaceous iron ore. In point of quality it appears to be inferior to the lower coal.

LOWER COAL FORMATION.

But two continuous beds of workable coal are ascertained to exist in the State of Michigan. The lowest of these lies at a small distance only above the limestone stratum, and is associated with a bed of shale, which is also sufficiently bituminous to answer the purpose of an inferior coal. The State geologist estimates the maximum thickness of this lower series at twenty feet. At Corunna, the county seat of Shiawassee county, on the border of the river of that name, is the best development of the lower coal bed that at present has been observed. It is the only locality in the State where coal has been raised for economical use, and even here the work is upon a small scale. It consists of a few shallow open pits sunk on the margin of the river and down to the level of its waters. This close proximity to the water renders the situation selected very unfavorable for mining. The coal bed is 3½ to 4 feet thick. In structure it is finely laminated, like the Ohio coal: the laminæ appear as if cemented together with bitumen. In quality it is excellent, highly bituminous, and brightly blazing; it is said to produce a very hot fire, and to be well adapted to the purposes of the blacksmith.

The coal is here covered by some thin beds of black bituminous laminated slate, by a course of nodules of argillaceous iron ore and by seams of black shale and clay. Then occurs a drab-coloured gypseous clay, and over that are the grey and yellow sandstones with impressions of coal plants; from some portions of this series grindstones have been made. The fossiliferous limestone, underlying the coal, crops out in the vicinity.

However excellent this coal appears at these small openings, its quality, and even its thickness, can scarcely be said to be now fairly tested; for, as at this precise spot there is no rock covering, it can only be considered as surface or crop coal.

We have been more minute in this notice because it is one of the very few localities which have been explored for the purpose of actually mining the coal over an area of several thousand square miles.

We have, during the year 1847, examined the outcrop of coal at several other points on the Shiawassee river, but the attempts at its development are, as yet, of a very feeble nature. The coal at all these positions was accompanied by overlying courses of excellent argillaceous carbonate of iron, and by beds of gypsiferous shales.

Dr. Houghton closes his annual report for 1841, by recording his belief that bituminous coal will be found in abundance, for all the wants of the State, and that it may be fairly inferred from the facts already determined, as to the range of the coal-bearing rocks, that coal will be found at numerous other points than those now ascertained, and also in several counties where it is not now positively *known* to exist, and where no attempts have even been made to pursue its traces.

Whenever these developments are completed, or even when they are but very partially extended, and when the area, quality and amount of productive coal beds in the situations favorable for transportation are determined satisfactorily, the geographical importance of such a vast district of bituminous coal must be apparent. The influence which it will exercise over the future prosperity of this new State can scarcely now be appreciated.—Centrally situated, accessible to all the upper lakes and rivers, around whose borders not a trace of a coal formation exists, the Michigan coal-field could have no rival. Should coal operations be conducted here on an adequate scale, and the means of transportation to the lakes be facilitated, the present price of mineral fuel will be greatly reduced. Anthracite in September 1847 obtained from $13.00 to $15.00 per ton at Detroit.

That we are not alone in our estimation of a coal-field so favourably circumstanced, in this portion of the American continent, we might quote a passage in the report to his Excellency, the Governor-General of British North America, on the geological survey of Canada, by W. E. Logan, Esq., 1st May, 1847.

"The great expense attendant upon the transport of copper ore to a distant smelting locality, naturally turns the attention of those whose minds are directed to the subject of mining it, to the aid to be derived, in its reduction, from such coal deposits as are most nearly situated to the region in which it exists. The geological structure of Canada appears to promise little in regard to this useful mineral; but in the states of the neighbouring Union, there are two localities on the great chain of lakes to which the mineral region of Lake Superior belongs; one at Cleveland, on Lake Erie, the other at Chicago, on Lake Michigan; within forty and sixty miles of which, respectively, coal might probably be made available. But in the heart of the southern peninsula of Michigan, which is still nearer the metalliferous

region, a third great coal-field is spread out; and in this instance the waters of Lake Huron appear to make a deep incision into the deposit in [near?] Saginaw Bay.

Saginaw Bay, therefore, appears to be the position naturally destined for the reduction of such copper ores as may result from the mineral region of Lake Superior. These ores, combined with the sulphurets reported to have been discovered on Lake Huron, seem to be sufficiently varied to give a favourable smelting mixture. The coal is of the bituminous description, and beds of fire-clay will be found supporting the seams. Unless some great change should be effected in the system of smelting copper ores, there is little doubt the produce of the Michigan mines will ultimately centre in this locality; and it can only be the operation of fiscal laws that will prevent the Canadian ores from finally reaching the same destination."

PEAT.

The geologist dwells, with much earnestness, on the abundance and value of the peat deposits of Michigan. This substance, he states, is of considerable importance, not only as a combustible, but as a manure. These peat beds are, like the coal seams, comparatively shallow, seldom exceeding four feet in thickness. It is of the fibrous kind, and by no means so compact as to form a good fuel. It most commonly overlies beds of calcareous marl, which has accumulated in the innumerable low meadows, beaver swamps, and wet prairies of the country. Michigan has been aptly designated by the Indians as "the land of lakes," and the State geologist has reported on the existence of not less than three thousand lakes within the limits of the peninsula. *Lignites* have not been met with in this country.

CENTRAL BITUMINOUS COAL-FIELD

OF THE

PLAIN OF THE MISSISSIPPI, USUALLY STYLED THE ILLINOIS COAL-FIELD.

We have separated this vast area into four divisions, corresponding with the respective States into which they extend, as follows:—

I. Indiana division.	III. Kentucky division.
II. Illinois division.	IV. Iowa division.

In making this classification, we have included no portion of the coal area of Missouri, from which there is, however, no other separation from that of Illinois than the Valley of the Mississippi. The Missouri region will be best treated on, separately, in the present instance.

I. INDIANA DIVISION.

To Dr. D. D. Owen's Geological reconnoissance of this state in 1837–8, we are chiefly indebted for what we are able to communicate respecting this imperfectly known region.

He states that the entire western portion of Indiana proves to be rich in coal, and although wood is extensively employed, as the cheapest or most convenient fuel at present, the axe is busily at work in the primitive forests, and the rapid increase of steam power, calling incessantly for fuel, is thinning them out from year to year.*

The reporter was unable, from the result of the reconnoissance of a single season, (1837,) to form any exact estimate of the area of this coal-field. He simply records the results of local examinations, while traversing the various counties. Limited, therefore, as is the information obtained in an area which covers several thousand square miles, we receive this contribution to American geology, with all the confidence which the known intelligence of the reporter deserves at our hands.

Bituminous coal, of the ordinary kind, abounds here, as well as cannel coal. On White river, the seams are upwards of six feet thick. Others are four and three feet thick, near Terre-haute.

If we were to reason from geological, or rather from mineralogical conditions, on the future position of Indiana, we should say that her western counties are destined to become, one day, the chief centre of manufacturing industry in that parallel.

Near the mouth of Coal creek, on the Wabash, in Fountain county, no less than six beds of coal are exposed, interstratified with argillaceous iron

* Owen's First Report of a Geological Reconnoissance of Indiana, in 1837.

ore and carbonate of iron. These coal seams vary from one foot six inches to four feet six inches thick, each.

At the Sugar creek foundry, in Parke county, is a three feet bed of cannel coal; or a coal nearly approaching to that variety.

An eight feet seam of good coal occurs in one locality; another in Clay county, four or five feet thick. On Honey creek, Vigo county, a four feet coal vein; as also on Lick Fork of Busseron creek. On the Patoka, in Pike county, is a bed said to contain nine feet of coal.*

The reporter is unable to state any facts to establish the identity and continuity of these coal seams, or how far they may be repetitions of the same series. He has, however, made analyses of many of these, which will be found in our tables at the end of this work. We conceive, that they are all approximate results merely; inasmuch as they are derived from outcrops, rather than from perfect coal of the mines, which, at the time of the survey, were not in existence.

Dr. Owen concludes his second report of Indiana with a summary of its geology. We have only now to do with that part which refers to the coal formation. This area is a part of a great coal-field, which includes nearly the whole of Lower Illinois, and eight or ten counties in the south-western part of Kentucky.

In Indiana, this bituminous coal formation occupies an area of about 7,700 square miles.

The coal exhibits its vegetable origin very distinctly. Layers of charcoal, from which the woody fibre can be readily detached, are frequent in the superior coal beds. The dip of the beds is westward, and they are of the same geological age as those of the Cumberland Mountains in Tennessee.

Peat occurs in this state.†

The following diagram shows a transverse section of the lower part of the Illinois coal-field, from the large section of Mr. Hall.‡

Fig. 17.

Transverse Section of the Illinois and Indiana Coal-Field.

a Coal measures. bb Carboniferous limestone.
c Old Red Sandstone—Portage and Chemung Groups—Waverley Sandstone.
d Marcellus Shale—Helderberg series.

The coal area of Indiana is only a portion of an immense western region, which a writer has asserted to be "fifteen hundred miles long by six hundred miles broad, and would cover half Europe."§

We hesitate before adopting his statistics, notwithstanding that we are, on the whole, disposed to agree with those who admit the possibility of a period when one single coal formation covered that part of the continent of North America, which extends from the Lehigh to the Missouri. But as we have only to do with the existing—not the theoretical, or antediluvian areas of these coal formations—we are compelled to state that the present maximum length of the great Illinois coal region is about three hundred and thirty

* Owen's Second Report of a Geological Survey, made in 1838. † Ibid. p. 47.
‡ Trans. Assoc. Amer. Geol. Vol. I. p. 267.
§ American Quarterly Review, March, 1839. Also Darby's View of the U. S.

miles, and the greatest breadth is two hundred miles. The actual area, containing coal, in the entire space, which comprehends portions of Indiana, Kentucky, and Illinois, is 56,200 square miles.

In Dr. D. D. Owen's paper read to the Geological Society of London, in November, 1842, but not published, *in extenso*, until November, 1846, we observe that the dimensions assigned by that gentleman differ very little from the preceding, except in the total area, which, he states, "equals the entire island of Great Britain." This is no doubt an accidental oversight, because that area is 83,828 square miles, or 88,052 including the Scottish Isles.

We may repeat here, that the other great bituminous coal-field, which is usually named the Alleghany coal region, is in the extreme length along its centre, seven hundred and fifty miles, and in average breadth eighty-five miles, containing 65,300 square miles.

The Illinois coal-field contains the caking variety, some splint, and some cannel coal.

A canal was opened in 1839, at Evansville, one hundred and eighty-eight miles above the mouth of the Ohio, which communicates with the extensive coal region in the interior of this state.

Length of Wabash and Erie Canal in 1847, three hundred and seventy-four miles; cost, $5,585,000; receipts, $500,000.

BITUMINOUS COAL OF CANNELTON.

We have been furnished with details from several parties, in reference to the cannel coal of this locality. It is situated in that part of the coal-field which is intersected by the Ohio river, at about 120 miles below Louisville by water, but scarcely more than half that distance in a straight line. The seam varies from three to four feet in thickness, and occasionally expands nearly to five feet.* It is entered, for the purpose of mining, by means of an adit-level, a quarter of a mile from the Ohio, at an elevation of seventy feet above the bank of that river. In regard to geographical position, therefore, the site is unusually advantageous, and the coal can be furnished at a corresponding low price.

The coal, for an inch or two of the upper part of the seam, contains less bitumen than the rest, bearing a slight resemblance to cannel coal, and decrepitating when burning. Two or three inches of the lower part consist of a highly bituminous shale. The remainder of the mass is of the finest quality, coming out in large blocks of a foot or eighteen inches in diameter, exhibiting vegetable traces. It burns freely, yields a pleasant flame, and affords a light sufficiently strong to enable a person to read by it.†

This coal was experimented upon by Prof. W. R. Johnson, and the results are detailed in his invaluable report to the Navy Department of the United States in 1844. He observes that the fracture is often conchoidal, and the lustre dull, like that of Scotch cannel coal. The surfaces are frequently covered with films of sulphuret of iron. Specific gravity was 1.247 and 1.297, the mean of which gives 79¼ lbs. per cubic foot. The mean result of two specimens gave the following proportions:

$$\left.\begin{array}{lr} \text{Of fixed carbon, - - - - -} & 59.40 \\ \text{Moisture and other volatile matter, -} & 34.90 \\ \text{Earthy matter, (3.49 to 8.16) - -} & 5.70 \end{array}\right\} 100$$

* Letter to Prof. Silliman, by B. Lawrence, Louisville, Nov. 20th, 1847.

† Letter of Prof. Frederick Hall, published in the National Intelligencer of Washington, July 1843.

Samples of the coal have contained a much smaller amount of earthy matter—in one case not much exceeding 2 per cent.

The observations of Prof. Johnson agree with our own experience:—"From its flaky texture it speedily disintegrates into flat masses, burning with little intumescence, and scarcely any tendency to agglutination. This property allows a free passage to the air, favors rapid combustion, and causes the exhibition of an exceedingly brilliant light. Its prompt and rapid action appears to adapt it, in a remarkable manner, to the purposes of western steamboats. It seems to bear transportation better than any other sample of bituminous coal which came under notice. It was the only really available sample forwarded for trial from the great coal-fields of the west."*

It is submitted to us, by the proprietors of this coal, that the specimens sent to Washington were intended to represent a perfect cross section of the seam of coal, including the inferior portions. Had the combustible experimented upon consisted solely of the better and main portion of the vein, they conceive that the result of the investigation would have probably been yet more favorable.

We may be permitted here to remark that we have, in the progress towards the completion of this work, received numberless communications from companies and individual proprietors of coal mines, in all parts of the Union. We have endeavoured to do strict justice to all, so far as our means and space permitted us to act discriminately, and without subjecting ourselves to the imputation of advocating particular interests. Whilst wishing success to all, we have never knowingly permitted the suggestions of interested parties to divert us from that course.

Prices of the Indiana cannel coal in 1847-8.—We are informed by a proprietor that from 2000 to 3000 bushels of this fuel are now sold daily, at the mine, to steamboats at 7 cents per bushel, $1.96 per ton. He adds that it can be afforded to manufactories near the mine at 4 cents the bushel, $1.12 per ton, and that it is, considering the *quality*, the cheapest coal in the world, at a position convenient for extensive manufactories.†

This field occurs, like most others, in the basin form: the bed of cannel coal at this place being the lowest in the series, which consists of two workable beds only, as we learn from a pamphlet recently published.‡ The lowest coal, as we have stated, occurs at Cannelton and at Trade Water in Kentucky; the upper seam is worked at Bon Harbour, and at various other places. At different points each of these seams varies from three to ten feet in thickness. The same bed of cannel appears also in Kentucky, Illinois and Missouri.

We observe in the pamphlet alluded to, that a ton of this coal is equivalent only to 26¼ bushels on the Ohio. The work terminates with the emphatic statement, in relation to this coal position, that, having the cheapest power, the cheapest materials, and the cheapest food, it possesses the means of manufacturing the cheapest goods in the United States.

The bituminous coal of Carr's Run, 160 miles below Wheeling, is put on board the steamboats for 6¼ cents per bushel, or $1.75 per ton. It is a lighter and drier coal than that of Wheeling, and less bituminous, but is considered to be better adapted for the steamboats of the Ohio.

* Report to the Navy Department of the United States, by W. R. Johnson, 1844.

† Hamilton Smith, Esq., January 1848.

‡ "The relative cost of steam and water power, the Illinois coal-field, and the advantages offered by the west, particularly on the lower Ohio, for manufacturing;" Louisville, 1848.

II. ILLINOIS DIVISION.

So much of the coal formation as is comprised within the State is, at the utmost, 44,000 square miles; but if due deductions are made for unproductive portions, for large spaces divided or removed by rivers and valleys, the real productive area would not, probably, be found to exceed thirty thousand square miles.

There is no coal on the Ohio river nearer to its junction with the Mississippi than Saline, near Shawneetown, 116 miles above the mouth of the first named river. On the Mississippi it is rather a shorter distance, being sixty miles to Muddy creek, and thence twenty-five miles up that creek to the first coal-bed there, or twelve miles by land. Some coal operations commenced here some few years ago, having in view the supply of the towns along the Mississippi, as far even as New Orleans. The present supplies of coal to the lower country are obtained from a vast distance up the Cumberland and Tennessee rivers, but especially from Wheeling, Pittsburg, and the intermediate points, 900 miles further from the market than the Illinois coal of Muddy creek. The estimated expense of delivering this coal at New Orleans, by arks, is about $2.25 per ton: while the minimum price of coal there is 25 cents a bushel, or $7.50 per ton. In winter time from 50 to 62½ cents per bushel, or $12 to $15 per ton, have been occasionally the retail price there. This Muddy creek coal seam is a horizontal bed 6 or 7 feet thick, above which is another vein, not heretofore worked. Coal can be thrown from the mouth of the drift into a boat. Its quality is most excellent, igniting readily, and caking together perfectly, without making much clinker. It has been used for 50 years by the old French settlers, to make edge tools, which have borne a high reputation.

What is termed St. Louis coal, supplied to the steamers, burns with a good flame, and cements like that of Pittsburg; ashes dark grey, in small quantity, and consumes with little waste. It is often mixed with yellow sulphuret of iron in flakes, occurring on each face of the sectional fracture; and consequently is not, we understand, in so good repute for the purposes of iron manufacturing.

At the present day, it is impossible to state precisely how much of Illinois and the contiguous States is occupied by productive beds of coal. The true coal producing area is probably but a fraction of the space comprehended within the geological limits of the carboniferous formations in those countries. This remark especially applies to Missouri and Illinois; in the former State, the coal prevails rather in detached patches, than continuously spread over the entire space. When persons speak of the vast area occupied by the coal formations in the western country, we must understand them as referring to the external limits of these areas, for we have no detailed surveys to show the extent occupied by the workable coal beds. We believe, in saying thus much, we but express the sentiments of every local observer in that quarter.

Towards the north-west boundary of this district, several coal seams are seen in the tongue of land which lies between the Mississippi and Rock

rivers. One of these beds is from five to six feet thick: its quality is fair, and evidently improves as the workings proceed.

To the south of Rock river are several good coal seams which are capable of supplying almost any required quantity of this fuel. Their local position and advantages render them of very great value to the country lying north of this.*

An article on the geology of Upper Illinois, appeared some time since, [1838] from the pen of Dr. C. U. Shepard,† in which are notices of the coal in that quarter. The outcrop of a six feet vein is described as occurring in the valley of the Illinois river. The same bed exists at Vermillionville, and is the most important of any in the district. In quality, it is a fat, bituminous coal, having equal proportions of carbon and of volatile matter.

The exact boundary of the coal-field has not been traced here on account of the great thickness of alluvial or drifted matter, which, as in Michigan, sometimes covers the coal measures to the depth of more than a hundred feet.

Dr. D. D. Owen's valuable paper was published in the Journal of the Geological Society of London, in 1846. He has ascertained that, with the exception of some slight shades of specific difference, there is a striking analogy between the fossil flora of the American fields and that of the equivalent strata in Europe. Among many others, he mentions that *Palms* are not uncommon, and some remains of Coniferæ (?) have been found. He also obtained remarkable specimens of the stumps of fossil trees (apparently palms) found standing erect with the roots attached, imbedded in slaty clay; and slender leaves have been found, in great abundance, in the near vicinity of the stumps, imbedded in the clay.‡

The author adds, that valuable beds of argillaceous iron ore exist in this coal-field, but that hitherto few furnaces have been in operation. He conceives that this ore must ultimately become an important source of income to the state, or rather to the proprietors residing in it.§

Stated production of coal in Illinois,	in 1839,	13,427 tons.‖
" " " "	in 1840,	15,417 "

Employing, according to the return to congress, 154 workmen, and $120,076 capital; probably much underrated.

CANALS.

This State, besides the vast extent of its navigable streams, possesses 374 miles of finished canals, which cost $5,585,000 and yielded in 1845 a revenue of $500,000.

* Owen's Report to Congress on the Mineral Lands. Doc. No. 239, p. 44.

† American Journal of Science, Vol. XXXIV.

‡ Models of these stems, illustrating their appearance in their original site, were exhibited by Dr. Owen, at a meeting of the Society of American Geologists and Naturalists.

§ Proceedings of the Geol. Soc. Vol. IV. Also Quarterly Journal of the same society. Vol. II. p. 433.

‖ Hunt's Merchants' Magazine, Vol. V. p. 434, and subsequently.

III. KENTUCKY DIVISION.

The south-eastern extremity of this vast coal region, stretches across the Ohio river into Kentucky, and occupies eight or ten counties in the north-western part of this state,* probably about 4500 square miles.

At Hawsville on the left bank of the Ohio, 120 miles below Louisville, is a coal bed four feet thick. The upper eighteen inches of this bed consists of Cannel coal; the remainder is common bituminous coal, two and a half feet.

Its analysis by Dr. Jackson, is	Carbon,	48.40
	Bitumen, &c.	48.80
	Ashes,	2.80
		100.00

The price of this coal at New Orleans, was sixty-two and half cents to one dollar per barrel, of two and a half bushels. It is in request there for the use of the tow-boat companies.†

Hawsville is about 258 miles above the mouth of the Ohio. The coal seam is nearly horizontal—appearing on both sides the river, in a position remarkably favourable for loading into vessels lying in the Ohio. It is a compact, largely conchoidal, coal, producing a bright flame; does not cement or adhere together in burning, but on the contrary falls into a profuse white ash, much larger in amount, practically, than the foregoing analysis exhibits.

Although 700 miles in advance of Pittsburg, it has been hitherto, we are told, unable to compete with that coal, which is floated down the Ohio in arks, and, it is said, can be mined cheaper. The boats and arks, in which the coals are conveyed down the stream, can also be built cheaper above; and moreover, the Pittsburg and Wheeling coal is estimated better for blacksmiths' use, &c. Still the Hawsville Cannel is especially liked for steam engines. For domestic use we think it is objectionable, on account of the great quantity of very white ashes which are left after combustion, filling up the grates, &c. to an unusual degree; at least such was the case in the supplies furnished on three or four occasions when we passed up and down the Ohio in steamboats. Altogether, it is greatly inferior to Lancashire Cannel coal.

It is specifically lighter than common bituminous coal, yet heavier than Cannel coal of Lancashire and Yorkshire.

Kentucky or Hawsville Cannel, spec. grav. - -	1.250
What is called the Cannel coal of Jackson county, Ohio,	1.410
Lancashire Cannel, - - - - - - - - -	1.199
Ingolton Cannel coal in Yorkshire, - - -	1.195

Caseyville Cannel coal, similar to that of Cannelton in Indiana, reported on by Professor W. Johnson.‡

* Owen's Report of Indiana, p. 39.
† Hazard's Register.
‡ Coal Report to the Secretary of the Navy, 1844.

Spec. grav. 1.39. The result of his analysis gave of

Volatile matter,	31.80
Fixed carbon,	44.50
Earthy matter,	23.70
	100.00

It will be observed that the proportion of earthy matter is unusually large, amounting almost to one-fourth, and agreeing with the practical remarks made by ourselves and others, on board the Ohio steamboats, on several occasions.

Petroleum.—Springs of this substance occur at several points.

An account is given in Silliman's Journal of a *Petroleum Oil well*, near Burksville, Kentucky. This was discovered some years ago, whilst boring for salt water, and after penetrating solid rock for two hundred feet, a fountain of pure oil was struck, which was thrown up more than twelve feet above the surface of the earth. Since that time it does not appear that the supply is sufficiently regular to furnish an important amount of this oil.*

Professor Mather reports that many hundred, perhaps many thousand, barrels, might be annually collected at the different petroleum springs in Kentucky; and that it commands a high price in the eastern markets.†

Gas Springs, evolving carburetted hydrogen, are not uncommon. They burn with a white flame, and are capable of useful applications, such as lighting and warming houses, boiling salt, &c.

A similar occurrence takes place at the Albion Mines, Nova Scotia; and we shall describe them, on a magnificent scale, in China.

IV. IOWA DIVISION.

This great bituminous coal-field has its north-western termination in Iowa Territory; occupying some ten or twelve townships, or about four hundred square miles, which we have included in our estimate of the Illinois field.

Not much was known as to the details of the coal seams here, at the period of Mr. Owen's survey, in 1840. Only one seam is adverted to, as cropping out west of the Mississippi, the coal of which was said to be of indifferent quality. Its analysis appears in our tables. There are several good coal seams on the eastern borders of the river in the Illinois portion.‡

According to official returns to congress, in 1840, there were 10,000 bushels, or 321 tons of coal raised in Iowa.

* Silliman's Journal of Science.

† Mather's Reconnoissance of Kentucky in 1838, p. 28.

‡ Owen's Report on the Mineral Lands of Iowa and Wisconsin, 1840, p. 44. Also in Revised edition of 1844, p. 53.

WISCONSIN.

Bituminous Shale and Limestone.—In the lead bearing magnesian limestone of Wisconsin, are occasionally observed thin seams or lamina of a buff coloured shale, which, on being placed on a fire, burns for a while with a moderate flame, after which the residue presents a preponderance of earthy ashes. This asphaltic shale is calcareous, and frequently fossiliferous. It has been, in the absence of other fuel, economically employed in lime burning, as it contains inflammable matter in sufficient quantity to calcine the limestone without additional combustibles.

Peat is very abundant throughout the valleys of the Mineral Region; and in a district where vegetable and mineral fuel is so scarce, seems highly probable, that it will at some future day be resorted to as an extremely valuable substitute for coal and wood. The valleys, of which we speak, present a very peculiar character, in one respect: which is in the singularly level planes which are maintained, in their entire breadth. They appear as if they had once been filled to a uniform level, in the manner of a dam, from bank to bank, or like artificial reservoirs from which the waters have escaped. These level bottoms consist of Peat beds, to an unknown depth; and small streams meander through them, having muddy bottoms, and frequently expanding in swamps. It would seem that these Wisconsin valleys, have acquired this peculiar uniformity of plane surfaces from the deposition of earthy matter in the first instance, succeeded by the growth and decay of that class of coarse aquatic vegetables which prevails under such circumstances.

In using the term "level" we apply it only in relation to the breadth of the valleys, and not to their length; for their inclination is often considerable, that is to say, from fifty to a hundred feet per mile.

MISSOURI STATE.

We are in possession, comparatively speaking, of but scanty geological information respecting this extremely important mineral state. We possess, as yet, no geological map of this vast region, and we have no authentic data whereby to fix the area of its coal formation. In the absence of these we have made an approximate estimate, whereby we think it very probable that at least one eighth of all Missouri is overlaid by coal measures. Every year, however, as cultivation advances, and the country becomes settled, new

localities of bituminous coal are determined. We conceive that we make no exaggerated estimate in assigning 6000 square miles as the amount of coal land in Missouri; being one tenth of its entire area.

Among the earliest notices of the existence of fine seams of coal, far up the Osage river, are those of Captain Pike, in 1806. More recently, other localities of excellent coal have been discovered nearer to the mouth of the same river, and it seems not improbable but the entire valley of the Osage river is a continuation of the same general Missouri coal-field. For the analysis of the Osage coal, see the tables at the end of this volume. *

The St. Louis limestone and the coal formation reposing upon it, have been described by Dr. G. Engelmann, in the American Journal of Science and Arts, January 1847.

The thickness of this upper carboniferous or mountain limestone, is between 200 and 300 feet.

The coal-bearing strata overlie it; below, directly upon the limestone, is a sandy, and above, an unctuous clay or shale; the whole about forty feet thick. On this shale rests a coal bed of three to five feet—the only workable one in this neighbourhood—covered by a thin stratum of clay, which itself is overlaid by 10 or 15 feet of a blue or brown limestone, the uppermost palæozoic stratum in the region.

Beneath the St. Louis Limestone is a sandstone, 50 to 100 feet thick, and this is succeeded by the lower carboniferous or pentremital limestone, which is probably 1000 feet in thickness.

Dr. H. King, who has seen this formation at the south-west parts of Missouri, thinks that on the Osage river, this lower limestone dwindles very much, but that the sandstone and the coal stratum above it, are much more developed; and that the fine coal mines worked there, sometimes not far above, and distinct from the lead-bearing magnesian strata, are in this same lowest coal-bed.

Bituminous coal, approaching to the quality of the European cannel coal, forms an important, but at present, not well defined bed in this state.

A very fair cannel coal is found at several points in Callaway county, north of the Missouri river, and also on each side of that river, 120 miles above St. Louis. Extraordinary statements have been put forth in relation to the immense thickness of the Callaway county bed of cannel coal; at one point 24 feet and at another 46 feet, thickness. In Coal county, a few miles from *Cote-sans-dessein*, it is affirmed that a shaft has been sunk 32 feet into the coal, without getting through the stratum; [?] probably an oblique section of the seam.

Cannel coal has also been discovered, in 1848, within eight miles of St. Louis, forming a bed of remarkable thickness.

In regard to the Callaway or *Cote-sans-dessein* cannel coal, before spoken of, we have seen testimonials as to its qualities from several well known scientific persons, and the results are in some measure to be inferred from their analysis. There is no doubt but the coal from this remarkable depository, is well adapted for steam purposes and for making gas, and by ironmasters it is considered to be well suited for the manufacture of iron. It cakes very readily, without much changing its form; producing a porous cake amounting to 59.95 per cent. of the coal. It has but a very slight trace of sulphur in its composition; a circumstance of some importance in relation to iron works, as many of the Missouri and some of the Illinois

* Also Mr. Johnson's Coal report to Congress; p. 539.

coals contain too much sulphur for those purposes. It is lighter than ordinary bituminous coal.*

The great variations in the thickness of this mass of cannel coal, at different points—for we presume that it is, in fact, but a single bed—have led to the supposition, by some, that the general arrangement is that of enormous lenticular masses, rather than disposed in a continuous flat seam. We are as yet without sufficient evidence of such a fact, as it seems scarcely consistent with the uniformity of stratification prevailing in this part of the country.

Should such a disposition really exist, we might find several parallel cases in other parts of the world. For instance, the remarkable coal seam in the basin of the Basse-Loire, in France, which is distributed in lenticular spaces, instead of in sheets, the average of which masses are stated to be forty-nine English feet in thickness.

Such also is the character of the anthracite of the departments of Mayenne and Sarthe, which combustible occurs in irregular masses of various sizes, but which are never much prolonged. The same features, in connection with the conformation of the bituminous coal, are observable in the basin of Haute Dordogne, or Champagnac, in France. Here also the coal is in lenticular masses, sometimes one hundred and twenty feet long and thirteen feet thick; but commonly the coal occurs in rognons, balls or spheres, from sixteen to thirty-three feet in diameter.

Production.—We can entertain but vague ideas as to the annual quantity of bituminous coal at present raised in this state. According to a congressional report, the amount which was mined in 1840 was only 249,302 bushels, or 8,903 tons. From much later returns, made at St. Louis, we are informed that the quantity of coals weighed at the city scale, in the year 1846, was about 1,700,000 bushels, and the estimated amount, in 1847, was 2,000,000 bushels, or 71,428 tons for that city alone. To these are added the Pittsburg coals and some anthracite, making the aggregate, in 1847, about 100,000 tons. A large portion of this advance is ascribed to the great increase in the number and business of the foundries and factories of St. Louis.

ARKANSAS.

Announcements of discoveries of bituminous coal have, from time to time, been made in this State, particularly in the vicinity of the Arkansas valley. At Spaldries' Bluff, in Johnson county, on the north bank of the Arkansas river, above Little Rock, coal was worked a few years ago, and we presume is continued at the present time.

* Notices by Messrs. Booth, Boyé, Johnson, Chilton, and others, contained in a report of the Callaway mining and manufacturing Co. New York, 1847.

At the request of the writer, Mr. J. F. Frazer kindly furnished him with the following result of his examination of this coal:

Carbon, - - - - - -	62.60
Volatile matter, including sulphur,	26.90
Hygrometric water, - - -	2.00
Ashes, - - - - - -	8.50
	100.00

Specific gravity, 1.396

Coal traces have been mentioned by Mr. Nuttall, as occurring near the western boundary of the State, towards Fort Smith, and extending many miles westward, at least as far as the Falls of the Canadian river, in the Indian territory, and southward to the borders of the Red river, in the country of the Choctaws.* Northward, in the Cherokee country, [Nebraska,] the coal formation has been determined as far as Grand and Verdigris rivers; and 120 miles still further north, in the Osage country, coal abounds on the Little Osage river,† and is evidently an extension of the great Illinois coal-field, which stretches from thence almost uninterruptedly for 450 miles, across the Missouri and Mississippi rivers, and thence beyond the Illinois, Wabash, and Ohio rivers, into the north-western angle of Kentucky.‡

The quantity of bituminous coal returned to Congress in 1840, was only 200 tons, evidently an incomplete account.

SOUTHERN MISSOURI.

PORTION ADJOINING TEXAS, PROPOSED TO BE CALLED NEBRASKA TERRITORY.

"About one hundred and fifty miles west from the confluence of the Arkansas and the Canadian rivers, in W. long. 97°, is the western limit of the great limestone and coal formation. The coal beds in this region are of great thickness, and are apparently extensive and numerous. This formation," says the narrator of Major Long's first expedition to the Rocky Mountains, 1820, "appears to be unconnected with the great [tertiary] coal formation along the base of the Rocky Mountains, and the sandstones of the two districts are remarkably dissimilar."‖

The same coal formation, also traced in this direction by Capt. Pike in

* Nuttall's Travels in Arkansas in 1819. Long's narrative in 1819, 1820.

† Pike's Narrative, in 1805-6-7. Bradbury's Travels in 1809, 1810, 1811. Sibley's Journal, 1817.

‡ Owen's Indiana Reports; and Mather's Kentucky Report.

‖ Long's first Expedition, Vol. II. p. 408.

1806, and by Mr. Nuttall in 1819, is the evident prolongation of the great coal region which traverses Illinois, Missouri, and part of Arkansas, in the direction of Texas. Beyond it, to the westward, is the great plain composed of red saliferous sandstones with gypsum; and beyond that, towards Taos and Santa Fé, the mountainous range contains a bituminous coal region.

"The geological constitution of the Prairies is exceedingly diversified. Along the eastern border, especially towards the north, there is an abundance of limestone, interspersed with sandstone, slate, and many extensive beds of bituminous coal. The coal is particularly abundant in some of the regions bordering the Neosho river, where there are also said to be a few singular bituminous or 'tar springs,' as they are sometimes called by the hunters. There are also many other mineral, and particularly sulphur springs, to be met with."

Further westward, the sandstone prevails, but some of the table plains are based upon strata of a sort of friable calcareous rock, which has been denominated 'rotten limestone;' yet along the borders of the mountains the base of the plains seems generally to be of trap and greenstone.* But much of the middle portion of this enormous prairie region exhibits no rocky traces whatever, so much so that "we sometimes travel for days in succession without seeing even as much as a pebble."†

Towards the head of the Osage river coal strata prevail, and with various other localities form detached or outlying areas, evidently portions of the coal-fields of Missouri, Illinois and Indiana. The same series are seen on the Arkansas river near Fort Smith, and at the Canadian Fork. We have also learned the interesting fact of the existence of large beds of coal at the head of the Canadian river, and in the Raton Mountains between Santa Fé and the Arkansas river.

To the northward, according to Mr. Nicollet, alternate areas of the cliff limestone and coal measures present themselves, on either side of the Missouri river, from its mouth to the junction of the Platte river, in 41° N. lat. To what extent the coal formation stretches to the east and west of the Missouri river within the parallel, we have no certain information, further than that the limestone ceases to appear on the surface beyond about the 97th degree of west longitude, and is there covered by sand, gravel, and erratic deposits.

WOOD COAL AND BROWN COAL.

In a communication to the Association of American Geologists, in 1845, Lieut. Johnston describes an examination made by him of a "Bluff" at Mount Waneus, on Red river. This bluff presents an escarpment of fifty feet high, in which are various seams of wood and wood-coal or lignite, intermingled with iron pyrites, and on the surface of the bluff alum crystallizes in considerable quantities. Permanent springs flow from the base, and taste strongly of alum. This formation, a sand passing into stone, was traced five miles back from the river, at the same general elevation. The seams of wood and sand alternate, and the author described them as of recent or postdiluvian origin; but it is near one hundred feet above the present low-water mark.‡

The calcareous strata in the vicinity of Fort Washita contain decided cretaceous fossils.

* Gregg's Commerce of the Prairies, Vol. II. p. 185, 1845. † Ibid.

‡ Proceedings of the Association of American Geologists and Naturalists, April 1845, p. 74, 76.

BITUMEN AND PETROLEUM.

On the False Washita river, towards the Wishetaw Mountains, Lieut. Johnston met with a dark sandstone with a vertical dip; out of which, throughout its course, a great quantity of bitumen has flowed. A specimen of the liquid bitumen has the consistence and appearance of common tar. It occurs as mineral oil on the surface of a spring near that place. We have no information as to the age of the rock, which is in the vicinity of granite.

MISSOURI TERRITORY.

BROWN COAL OR LIGNITE FORMATION OF THE UPPER MISSOURI VALLEY.

Limiting our description in this place to that portion of this enormous area of brown coal, which lies within the United States territory, south of 49° of north latitude, and east of the Rocky Mountains, we will place before our readers such information respecting this extraordinary region as we have been able to acquire.

From the mouth of the Missouri river upwards to the Platte river, the carboniferous and cliff limestone of the American geologists, with occasional shallow basins of the true coal formation occur, and the carboniferous limestones extend still further to the mouth of the Sioux river, lat. 42° 30′. Here commences the interesting formation first described by Mr. Nicollet, belonging to the cretaceous group, with calcareous marls containing microscopic multilocular shells, resembling those discovered by Ehrenberg in the chalk, and other beautiful fossils of larger size corresponding with those in the chalk, the gault, and the green sand formations of Europe. Mr. Nicollet traced this group up the Missouri river for four hundred miles, but it is known to extend as far as beyond the Mandan village, to a point between Beaver river and Grand river, at about N. lat. 47° 30′; thus occupying, in that direction, 5 degrees of latitude.

At this point, and overlying the cretaceous series, commences the vast tertiary area, composed of horizontal strata of variously coloured sand, clay, shale, sandstone and coal, irregularly alternating; extending at least twenty degrees to the south-west and south, and northward, apparently, to the arctic ocean.

The first notice that we have met with of this formation is in the narrative of Lewis and Clarke's expedition to the Rocky Mountains, in 1804. The coal or lignite was first observed at twenty miles above the Mandan villages. The bluffs on each side of the Missouri are upwards of one hundred feet high, composed of sand and clay, with many horizontal strata of carbonated wood, resembling pit-coal, from one to five feet each in thickness, and occurring at various elevations above the river.

At fifty miles above the villages, similar coal seams were noted; but here they were observed to be on fire, emitting quantities of smoke and a strong sulphurous smell. This point was 1652 miles above the Mississippi. Further on, the same sulphurous coal continued for eighty miles more; strata of coal, frequently in a state of combustion, appearing in all the exposed faces of the bluffs. The quantity of this coal improved as the party advanced near the mouth of the White Earth river, eighty-five miles further, affording a hot and lasting fire, but emitting very little smoke or flame. Thence forty-seven miles to the Yellowstone river, and at a bluff, eight miles up that stream, were seen several strata of coal.

The narrator observes, that for fifty miles above this junction, there were greater appearances of coal than had yet been seen, the seams being in some places six feet thick; and there were also strata of burnt earth, which were always on the same level with those of coal.

The explorers had thus far traced this coal formation along the banks of the Missouri, for a distance of three hundred and thirty miles. The horizontal formations of clay, loam and sand, with fragments of coal in the drift of the river, extended three hundred miles more, to Muscle-Shell river, or six hundred and twenty miles from the Mandan villages. Even above this point, washed coal continually appeared on the shores of the river; and at Elk Rapids, eight hundred miles from Fort Mandan, the high bordering bluffs were still composed of horizontal beds of clay, brown and white sand, soft, yellowish white sandstone, harder dark-brown freestone, and large round, or kidney-shaped nodules of clay iron ore. Coal, or carbonated wood, similar to that previously observed, was also seen, and was accompanied with burnt earth—probably the result of the spontaneous combustion of the coal, as was noticed for hundreds of miles below. Precisely the same phenomena were recorded, at a subsequent period, by Captains Back and Franklin, and by Dr. Richardson and others, and by Hearne in 1769, and Mackensie in 1789—extending, apparently continuously, and in the same parallel, full eighteen hundred miles, northward.

Returning to the narrative of Lewis and Clarke.

After reaching the grand forks of the Missouri, and ascending two or three days journey up Maria's river, northward, it was remarked that precisely the same geological character and coal strata prevailed, for more than sixty miles. So far, therefore, the exploring party had been travelling through or over a ligneous deposit, of singularly uniform character, for no less than nine hundred and eighty miles, following the windings of the river. Pursuing the south fork, towards the great falls of the Missouri, coal was still observed, in bluffs of dark and yellow clay, at a distance of 2454 miles up this mighty river, and it was not until near the base of the Rocky Mountains, and after one thousand miles of travelling across it, that this great region of coal beds and lignites was passed.

On his return, Captain Clarke descended the Yellowstone, from about North latitude 45° to its mouth in latitude 48° 20′, and every where found the same series of coal and variously coloured clays, sands, and soft sandstones, as was traversed in ascending the Missouri.

The fossil bones of a supposed fish, probably a saurian, were also observed above the Big Horn river. Large quantities of brown coal were seen in the cliffs below the junction of this river, and all the highlands adjacent appeared to be composed of earthy beds of different colours, abounding in coal or carbonated wood, of an impure quality. Below the Big Horn is a large stream falling in from the south, whose Indian name implies "the coal creek," from

the great quantity of that mineral upon its margin. The same coal series continued to the confluence of the Missouri, exhibiting uninterruptedly, for seven hundred miles, in addition to the thousand previously traversed, the vast persistence of this formation. The enormous area of similar strata is further shown by the discoloration of all the tributaries that enter the Missouri, both from the south and the north, from the forty-second to the forty-ninth degrees of north latitude.

On the authority of M. Sublette, these lignite beds prevail along the whole of the country watered by the Padouca [Powder] river, in beds of from three to nine feet thick; and also on the Batsoah or Cherry river, and the south fork of the Platte river; thus bringing the formation southward to latitude 40°.

It appears probable, from Capt. Fremont's narrative, July, 1843, that the sandy and clay beds which he crossed at the head waters of the Platte and Arkansas rivers, are southern continuations of the same formation to latitude 39° and 38° where the underlying yellowish and grey limestone, containing cretaceous fossils, first made its appearance in that direction, and is traceable eastward down the Smoky Hill fork, nearly to its junction with the Republican fork of the Kansas river. Colonel Long, in 1820, descended the Canadian or South fork of the Arkansas river, in which the prevailing rock is red sandstone, with salt and gypsum. It would seem, therefore, that our tertiary lignite formation ceases before reaching the latitude of 35°. But coal of some kind has been noticed by Col. Emory in latitude 36° 30′, at the head of the Canadian river.

Seams of lignite and wood coal are, however, observed on supposed tertiary strata on the borders of the Red river, and limestones of the cretaceous period likewise occur in the same country, in the vicinity of Fort Washita.

It was announced, in 1841, that bituminous coal, probably brown coal, had been discovered on the St. Peter's river, in the Missouri territory.

UPPER MISSOURI.

PROPOSED NEBRASKA TERRITORY.

In 1843, Messrs. Audubon and Harris ascended the Missouri to the mouth of the Yellowstone river. The latter gentleman has furnished some account of this tertiary lignite region.* The whole series of strata, for many hundred miles prior to reaching this formation, is described as perfectly horizontal; the upper part of each bed or rock being successively intersected by the angle of descent of the river. The tertiary group is indicated by the remarkable strata which form the picturesque hills noticed by travellers, and called the Mauvaises Terres by the trappers and voyagers. Mr. Harris counted, in one place, eight seams of coal, between the river

* Proceedings of the Academy of Nat. Sciences, Philadelphia, May, 1845.

bank and the top of the bluff; varying from six inches to four feet in thickness. This coal, he observes, is very light, and ignites with difficulty, emitting a very unpleasant odour while burning. Fossilized wood is very abundant; occasionally much flattened by the pressure of overlying strata. Mr. Bell was the only one of the party who had an opportunity of witnessing the burning of the cliffs, about thirty miles above the Yellowstone, on the northern bank of the Missouri; and all agree in attributing this burning to the spontaneous combustion of the coal. We observe, that Mr. Harris states that the coal seams commence in the upper part of Nicollet's great cretaceous clay bed; and further, that there occurred in the same formation, "a substance like petroleum in colour and consistence, but without odour."*

To the foregoing brief abstract we may add, that, from the specimens brought home by the last named traveller from the vicinity of Fort Union, near the confluence of the Yellowstone and Missouri rivers, we derive incontestible proofs of a fresh-water formation. Among other strata exposed in a cliff near the fort, are thin beds of clay and argillaceous rock, both containing three or four species of fresh-water univalve shells. There is, besides, a rock, twenty or thirty feet thick, which also contains proofs of fresh-water origin, in bivalve shells, leaves of deciduous trees, and bones, apparently, of a mammiferous animal.

The Upper Missouri Valley has yet to receive examination from the scientific geologist, and there can be no doubt but highly interesting results would follow from investigations in a field so rich and extensive. The committee, to whom Mr. Harris's paper was referred, close their report with the remark, that "the proofs thus afforded of a probably widely diffused fresh-water formation in the region of the Upper Missouri, reposing upon the cretaceous strata, and imbedding remains of a manifestly tertiary age, are, just at this time, invested with considerable interest, from their according with the discoveries recently made by Captain Fremont, of the presence of other and probably extensive fresh-water tertiary strata in the Oregon territory."

We have, in that portion of this volume which is appropriated to British America, supplied many additional facts respecting the central and northern parts of the great tertiary range, whose southern area we have been considering, above. From the united testimony of highly competent observers, there now remains very little doubt, that a continuous tertiary coal formation stretches from the Missouri and the Yellowstone, and even from near the sources of the Platte, and some branches of the Arkansas, and the borders of New Mexico, to the far distant shores of the Arctic ocean.

IRON MANUFACTURE AND TRADE OF THE UNITED STATES.

	Tons of Pig Iron.
In 1831, there were 939 iron furnaces, forges, &c. which produced - - - - - -	191,536
In 1840, 804 furnaces and 795 bloomeries, forges, &c.	286,903

* The cretaceous fossils brought by Mr. Nicollet from hence, were described by Dr. S. G. Morton, in the Proceedings of the Acad. of Nat. Sciences, Phila., October 1841. He had previously identified the fossils brought by Lewis and Clarke from the same localities; and, subsequently, others by Mr. Nuttall, as belonging to the cretaceous group, in Silliman's Journal, 1830. Also in his Synopsis of the organic remains of the cretaceous group, 1834.

A writer in the "Merchant's Magazine," March, 1845, gives the following estimate of the production of iron in the United States at that period:

		Tons.
540 blast furnaces, averaging 900 tons each, per annum,		486,000
950 { bloomeries, forges, rolling and slitting mills, yielding of bar, hoops, &c.		291,600
and of blooms, castings, machinery, stove-plates, &c.		151,500
The market value of these, in 1845, was	$33,940,500	
Quantity of bar, hammered, pig, scrap, and sheet-iron, and steel imported,		92,077
Value of the same,	$7,794,110	

From a sketch of the American iron trade and production by Mr. Feuchtwanger, in November, 1847, it appears that the quantity of pig iron produced in the United States in 1810, was 53,908 tons. In 1847, above 500,000 tons.

The value of manufactured iron and steel *imported* into the United States, during the year ending June 30th, 1846, *paying duties ad valorem*,	$4,023,590
Paying specific duties,	4,463,739
Total,	$8,487,329

	1844.	1845.
Value of American iron and manufactured iron exported,	$716,332	$845,017

Wire Cables for Mines and Inclined Planes, for Tiller Ropes, &c.—See much practical data collected under this head in article Prussia.*

Prepared Fuel.—See various details collected under the heads of South Wales, Holland, China, &c.

Casualties of Miners.—Provident Institutions, "*Caisses de Secours,*" Relief Funds, &c. see details under this head, in a preliminary chapter.

As regards the relief and support of aged or disabled miners in the United States, particularly in Pennsylvania, it is but justice to the editor of the Miner's Journal, of Pottsville, to state, that he has sought on several occasions to attract attention to this very desirable object. The casualties to which this class of useful operatives is continually exposed, calls for some provision for the aged, the infirm, and the injured; and for occasional relief in distressing cases, to their bereaved families. All mining countries have perceived the necessity of adopting measures which shall effect these benevolent objects, in behalf of a population whose employments peculiarly and perpetually expose them to the most distressing calamities.

The countenance of the state government would not, of course, be withheld from "The Miners' Provident Institution," but it is obvious, and has been decided in every well regulated mining region, that the burden and the management of such institutions as are here suggested, must be jointly borne by, and emanate from, the two most interested parties—that is to say, the proprietors of the minerals and the workmen themselves.

The community, as experience has shown, will not consent to be taxed for the relief of one class of operatives, however strong their claims. All

* For a classification of the respective rates of duty on chain cables and wire ropes imported into France from the United States, vide "Documens sur le Commerce Exterieur, Octobre, 1844." They are rated, for the most part, at thirty per cent. on their value.

other classes of persons pursuing hazardous occupations, would view such a measure as an act of injustice to themselves. Above all, should be avoided the conversion of benevolent institutions, however well conceived or modelled, to any thing like local or political influence.

In England, the operative miners have held back from such institutions, under the impression that the amount of their subscriptions would be so much deducted from the poor-rates, and, consequently, that their contributions would in reality prove a bonus to their employers, rather than a benefit to themselves. In the coal regions of the American states, no such objection can be urged, as the rates for the support of the poor are extremely trivial: and it seems most just and fitting that the operatives should, as in France and Belgium, have a share through their representatives, in the management and appropriation of the funds to which they have contributed their portion.

At the commencement of this work, we devoted some space to a consideration of this subject, and we conclude by referring the reader to that article, which abounds in facts of extreme interest.

Railroads in the United States.

	Miles.	*Cost.*
In 1845–6, there were in activity 113 public and private railroads, whose aggregate length was	4870	$127,417,758
Average cost per mile, $26,932=£5,564.		
In 1846–7, completed lines, 133,	5703.12	
		Capital.
In 1847, by "Doggett's Railroad Guide," there were completed,	5740.00	$122,525,937

Canals of the United States.

	Miles.	*Cost.*
Cost of 57 canals, up to 1845, length,	4102	$113,934,163

Lines of Magnetic Telegraph.

	Lines.	*Miles.*	
At the end of 1847, finished,	18	2311	in operation.
	7	2586	under construction, nearly finished.
	10	3815	to be completed in 1848.
Total,	35	8712	
		1768	projected.
Total Telegraphic conductors,		10,480	

Summary.

Aggregate of the 57 canals of the United States, in 1845,	4102 miles.
" of Railroads finished in 1847,	5740 "
" of Lines of Magnetic Telegraph,	8712 "
	18,554 "

Tonnage owned in the principal maritime States.

	1845. Tons.	1846. Tons.
New York, - -	625,875	655,695
Massachusetts, - -	524,994	541,520
Maine, - -	320,059	358,123
Pennsylvania, - -	147,812	148,058
Louisiana, - -	170,525	181,258

Comparative view of the registered, enrolled, and licensed commercial Tonnage of the United States, exclusive of those engaged in the Fisheries.

1815.	1820.	1830.	1840.	1845.	1846.
1,368,127	1,280,166	1,191,776	2,180,764	2,417,002	2,562,084

Tolls received on State works—Canals and Railroads.

	1845.	1846.
New York, - -	$2,620,532	$2,764,121
Pennsylvania, - -	1,196,979	1,295,494
Ohio, - - -	495,313	630,770
Indiana, - - -	46,279	53,930

Steam vessels.

Number of steamboats, plying from Philadelphia to different points on the Delaware and its triburaries, and to New York. 1844—35 boats, consuming 45,000 tons of anthracite.

In New York and its waters. 1844—consuming 100,000 tons of anthracite.

Steamboats on the western waters. 1846—1500 boats, whose tonnage was 145,311 tons.

Steamboats on the Lakes. 1846—80 boats, whose tonnage was 54,486 tons.

War steamers. 1846—11 boats.

Foreign Commerce of the United States in 1847.

	Cleared for foreign ports.			Arrivals.			Value of Exports and Imports, including Specie.
	Vessels.	Tons.	Crews.	Vessels.	Tons.	Crews.	
American vessels,	8,102	2,202,393		7,730	2,101,359		Imports, $146,545,638
Foreign vessels,	6,268	1,176,605		6,499	1,220,346		Exports, 158,648,622
	14,370	3,378,998	165,792	14,229	3,321,705	163,889	$305,194,260

Value of Imports in 1827, $79,484,068.

BRITISH AMERICA.

***Area and Population of the British American Provinces, and Territories on the North American Continent, in* 1846.**

Provinces.	Square miles.	Population.	Rough estimate of area of coal land, square miles.	Remarks.
Lower Canada, -	194,815	693,649		None ascertained.
Upper Canada, - -	147,000	506,055		" "
New Brunswick, -	27,700	130,000	8,000	Dr. Gesner's report.
Nova Scotia and Cape Breton, - -	17,500	199,870	2,500	Nova Scotia.
			250	I. C. Breton, Sydney distr.
			104	I. of Boularderie, Cape B.
			180	II. S. coal-field, "
			Not defined.	III. W. " "
			"	Chiefly a coal formation
Prince Edward's Island,	2,134	34,666	5,000	at least.
Newfoundland, -	35,913	81,517	Not defined.	Magdelene Islands, coal,
	425,062	1,645,757	Say 16,000	as the mininum.
British Territory, up to 70° N. latitude and 140° W. longitude, deducting lakes and bays, - - -	2,574,938	Unknown.		
	3,000,000			
British Honduras, -	62,740	3,958		
Total British possessions in N. America,	3,062,740			

Money.—Canada Currency.

1 English shilling = 1*s*. 1*d*., Halifax currency.
1 shilling currency = 10 pence, English.
20 shillings = one pound = 16*s*. 8*d*.
£1 sterling = 8 per cent. premium.
The American and Spanish dollar is 5 shillings, Canada currency.
1 Pistareen = 1 shilling, Halifax currency.
1 French five franc piece = 4*s*. 8*d*., Halifax currency.
To change Halifax currency [4 dollars = £1 currency] into British sterling, deduct one tenth.
To change British sterling into Halifax currency, add one ninth.

IMPORTATION.

By act of the Colonial Legislature, dated July 5th, 1843, all coals are allowed to enter the British American Colonies, free of duty.

Importation of Caal and Culm from Great Britain into British North America, from the Parliamentary Returns.

Years.	Tons.	Years.	Tons.
1831,	31,134	1840,	52,175
1832,	47,506	1841,	55,177
1836,	44,302	1844,	58,928
1837,	49,754	1845,	79,359

Importation of Iron from Great Britain to the British North American Colonies.

	Bar.	Pig.
1844,	11,029 tons	2991 tons

INLAND COAL TRADE.—IMPORTATIONS FROM THE UNITED STATES.

From Ohio.—Bituminous Coal Imported from Cleveland.

Years.	Tons.	Years.	Tons.
1837,	6,605	1842,	2,020
1838,	2,639	1844,	1,240
1841,	1,559		

Of the coal exported into Canada from the Port of Erie we possess no details.

American coal received at Toronto in 1846, 1143 tons. Importation of American coal is diminishing annually.

There is very little reciprocity in the trade between Ohio and Canada, as may be seen by the following official statement for the year 1844:*

	Value.	No. of vessels.	Tonnage.
Exports from the port of Cleveland to Canada,	$618,837	210	21,544
Imports from Canada to Cleveland,	10,738	101	12,534

We possess no recent British returns of the amount of American bituminous coal which passed through the Welland canal; but it is understood that three-fourths of the property which passes this canal is conveyed in American vessels on American account.†

Tonnage, of all descriptions, on the Welland Canal.

Years.	Tons.	Tolls.	No. of schooners.	No. of scows.
1834,	37,917			
1837,	80,697			
1838,	95,397			
1840,	202,282	£18,037	1863	700
1841,	247,911	£18,583	1895	972

Rates of toll in 1845, on American coal on the Welland canal, for passing through the whole line, 2*s.* 6*d.* per ton. Between St. Catherine's and Port Dalhousie, 4*d.* per ton. Sea coal free of toll.

* Report of the Secretary of the Treasury of the United States, January 1845.
† Report of Lieut. Col. Kearney, U. S. T. E.

Through the Welland canal the navigation of the lakes is uninterrupted for the distance of 844 miles, from east to west, and the extreme distance from south to north is 347 miles.

The British trade on the *upper* lakes, in 1845, was only about one-tenth the value of the American lake trade, as appears from the following statement:*

American trade, valued at $1,517,132, employing 550 sailing vessels, and 49 steamers.

British trade on upper lakes, $150,000.

By a report, furnished in 1847, of the Secretary of the Treasury of the United States, it appears that in 1846 there were 30,000 tons of British shipping employed in transporting American goods on the lakes generally. The *bona fide* value of the American Lake trade, in the same year, is returned at $61,914,910.†

Colonel Abert, of the United States Topographical Engineers, reported in 1847, that the existing tonnage on the upper lakes, in a military point of view, is sufficient for 100,000 men. The British tonnage is small on the upper lakes, only 4,500 tons; propellers 2,500 tons.

On Lake Ontario the British have the advantage in the number of steamers, description of vessels, and number of mariners.

Lake Champlain is exclusively American.

American tonnage, 1846,	106,836 tons
British tonnage,	46,575 tons

Exportations of Coal to the United States from the British Colonies of North America [Nova Scotia and Cape Breton:] from the U. S. official Returns.

Years.	Tons.	Value. Dollars.	American Tariff. Per heaped bushel.	American Tariff. Per Ton.
1802	233	$588	Duty, 5 cents, from 7th June, 1794.	$1.40
1804	388	978		
1832	41,934		6 cents, from May 2, 1824, per bushel.	$1.68
1834	51,777			
1836	78,212			
1838	71,908			
1840	85,951			
1842	73,114		From August 30, 1842, per ton.	$1.75
1843	64,186			
1844	57,211			
1845‡				
1846	95,330	195,452	From Dec. 1, 1846.	30 per cent. *ad valorem* duty.

There are no duties, either of exportation or importation of coals, from or to British America. A drawback is allowed by the United States on foreign coal re-exported, as in the instance of the depots of Pictou coal for the use of the British steamers. The law passed in January, 1840.

* Hunt's Merchants' Magazine, 1842.
† See further details of the American Lake Commerce.
‡ Boston alone, in 1845, 42,035 tons.

PROVINCES OF CANADA.

The area of East and West Canada is 341,815 square miles. Population in 1846, 1,199,704.

The result of the geological survey of Canada, as reported on by Mr. Logan,* sets at rest the question as to the existence of workable beds of coal within these provinces. None such have been traced; although there is, at Gaspé, a set of rocks overlying a series which corresponds with the old red sandstone, and the Chemung and Portage groups of New York, which rocks undoubtedly belong to the carboniferous series, though the part resting in Canada appears to be too low down to be associated with the profitable seams of coal.

Mr. Logan, in tracing the conglomerates and sandstones of this series round the Chaleur Bay in Canada East, to Bathurst in New Brunswick, has determined their relation to the nearest coal seams of the latter province with a considerable degree of certainty. The general dip of the Canadian part of the carboniferous deposit accords with this relation. Its slope towards the Chaleur Bay would carry it beneath the coal-bearing strata observable on the south or New Brunswick side; while no rock of a similar quality is there seen to overlie the coal measures.

The reporter concludes with the observation that the conglomerate rocks with which fossilized coal plants (rarely sufficiently abundant to constitute even a very thin coal seam) are associated, within the limits of his survey, appear to be the very base of the coal series, in so far as Gaspé is concerned, and their distribution in Canada is just sufficient to show that a very narrow margin, on the north shore of the Bay Chaleur, may be considered the limit, in that direction, of the great eastern coal-field of North America.†

Black bituminous shales in the Gaspé District.—In the lowest of these were observed nodules occasionally resembling septariæ, in which the divisions or veins hold a mineral undistinguishable, in its general appearance and combustible nature, from good sea coal.

The whole group was determined by Mr. Logan to be about 1140 feet thick, and is apparently the equivalent of a part of the Hudson river group of the New York geologists. Its position is, therefore, a very considerable distance below that of the true workable coal-bearing measures, and we are not warranted in expecting coal seams to exist in it.

Here, and in the vicinity of Quebec, as in New York, erroneous expectations have been formed, and consequent disappointments have ensued, that these black bituminous shales indicate the proximity of workable coal.

Some of them hold a sufficient quantity of bitumen to yield a bright flame when subjected to a strong heat.

* The progress of the geological survey is marked by a preliminary report, dated Dec. 6th, 1842, by Mr. W. E. Logan. A report by the same geologist, dated April 28th, 1844. A report from Mr. A. Murray, assistant geologist, March 14th, 1844. Report from Mr. Logan, May 1st, 1845; and from Mr. Murray, April 20th, 1845.

† Geological Report of Progress, Montreal, May 1st, 1845.

Carbonaceous shale and coal plants in the Gaspé sandstones.—This group, which Mr. Logan's detailed section shows to be 7036 feet thick, appears to comprise what in the New York succession is termed the Chemung and Ithaca groups, with perhaps a portion of the old red sandstone or Devonian series. Towards the lower part are beds containing abundance of fucoid-like plants; while near the base is a small seam of coal and carbonaceous shale, together measuring three inches, which appears to hold a regular course, having a bed of clay beneath it. The middle portion of the group contains seams of argillaceous shale and sandstone, in which are balls or nodules of argillaceous ironstone.

LOWER CANADA.

Petroleum Springs.—According to the report of the provincial Geologist, there are two petroleum springs in the neighbourhood of Gaspé Bay.

The first is situated on the south side of the St. John's river, about a mile and a half above Douglastown. The bituminous liquid oozes from the mud and shingle of the beach, at intervals for about three-quarters of a mile.

The position of the other petroleum spring is on a small fork of the Silver brook, a tributary of the south-west arm. The liquid collects on the surface of the water, in the form of a thick dark green scum, which can be taken up with a spoon. The odour could be distinguished for one hundred yards around.

Bituminous Trap Dyke, Gaspé Bay.—In some parts of the Dyke, the petroleum druces are so numerous, that there is scarcely a fragment the size of the hand that does not contain several of them, and the tar-like smell of the mineral is perceived in walking by the Dyke, at the distance of fifty yards. In some of the cavities the liquid is hardened into a resinous pitch-like condition.*

UPPER CANADA—WESTERN DISTRICT.

Naphtha and Petroleum in the corniferous limestone—cliff limestone of Ohio. This rock, which is the highest in the geological series described by Mr. Logan as existing in West Canada, and a member of the Onondaga limestone group, contains, in the township of Cayuga, north of Lake Erie, much bitumen. When struck with the hammer, this rock gives out a peculiar odour, denoting the presence of naphtha. This substance is frequently seen occupying small cells, from which a sufficient quantity can be collected to determine its character. Near London, the naphtha or petroleum is found floating on the surface of the etangs, or stagnant waters of the Thames, and which is frequently collected by means of a piece of cloth.†

Peat.—In the vicinity of Port Daniel, in the Gaspé district, peat is extensively spread.

The Eastern Provinces of British America have for some years had the benefit of examination by several resident gentlemen, as well as travellers, highly advanced in science. We shall frequently have occasion to quote from the reports of these writers, details of a very interesting character in relation to the carboniferous formations that occupy so large a portion of the area of those countries.

* Report of Progress of the Geological Survey of Canada, for the year 1844, p. 41.
† Rapports sur une Exploration Géologique de la Province de Canada, 27 Jan. 1845, p. 92.

PROVINCE OF NEW BRUNSWICK.

The area of this province is 27,700 square miles.

Bituminous Coal-field.—The entire area of coal measures within the province, is locally subdivided into several districts, of which the following are the principal.

I. The great northern coal-field.

II. The Westmoreland, or south-eastern.

III. The Sunbury and Queen's county, or south-western.

The aggregate area of these was estimated, in 1840, at five thousand square miles. Dr. A. Gesner, in a communication to the Geological Society of London, in 1843, stated that the area of the coal-field in New Brunswick had been recently determined to be seven thousand five hundred square miles; or ten thousand square miles, including Nova Scotia, but exclusive of Cape Breton.* These coal measures are described as usually lying in long parallel troughs, or in oval basins. Since the first report of Dr. Gesner, he has explored the whole of this vast region. The result of this geological survey is, that the coal formation is found to occupy, in New Brunswick, no less than eight thousand square miles. Here the most productive coal beds prevail in the interior, while those of Nova Scotia occur on the shores of her bays and rivers, where they offer every advantage for mining operations. The coal-fields of the two provinces are united at the boundary line, and belong to one carboniferous period.† The developments of almost every season illustrate more clearly the magnitude of these coal areas, which extend from Newfoundland, by Cape Breton, Prince Edward's Island, and Nova Scotia, and across a large portion of New Brunswick, into the state of Maine.

Sir I. E. Alexander officially reported, January 5th, 1846, that the great field of New Brunswick and Nova Scotia covers a surface of upwards of nine thousand square miles; but Dr. Gesner, the provincial geologist, much exceeds that estimate, as we have seen above.

I. *The great Northern Coal-field.* Mr. Henwood, a geologist of high standing, observes, that "the beauty and extent of these coal measures it is impossible to describe. In fact, we pass over nothing else, from Fredericton, on the St. John's river, to Miramichi, and thence to Bathurst, a distance of at least a hundred and fifty miles. They consist of various beds of sandstone, shale, and conglomerate, with numerous thin seams of coal, few of which are more than a foot or two in thickness. The whole of this district is particularly rich in fossil flora."‡ The coal measures, whose lowest members are the conglomerate beds, are perfectly horizontal in the banks of the Nepisiguit, near Bathurst, and these repose upon granite.

An interesting geological phenomenon has been observed here. In one of the thick beds of blue shale overlying the granite, and containing ferns and other fossil plants, occur lignites, which are impregnated in their

* Proceedings Geol. Society, Vol. IV. p. 182; reprinted in Journal Franklin Institute of Philadelphia, June, 1844.

† Mineral Wealth of Nova Scotia,—Gesner. Also Mining Journal, 19th July, 1845.

‡ Transactions of the Royal Geological Society of Cornwall, 1840.

laminæ, as well as in their cross fracture, by *rich, vitreous copper ore*, and coated with green carbonate of copper. Other lignites, also containing vitreous copper ore, occur in Nova Scotia, in the neighbourhood of Pictou, in considerable quantities, under precisely similar circumstances, within the coal formation.*

Something like this is of not uncommon occurrence in the United States, in the cupreous lignites of the red and blue shales at the base of the old red sandstone, or Devonian system. We have observed them at numerous points in Pennsylvania.

These lignites occur as casts of reeds, canes or flags; generally obscure, and the impressions of leaves seem in some degree to resemble those of the coal series above. The copper is in form of rich grey sulphuret, the surfaces of the lignites being coated with green carbonates. In more than one or two instances a good deal of expense has been incurred in exploring this ore, but we have never seen it in sufficient quantity to repay the cost. Copper seems invariably to accompany this bed of lignite; at least it is seldom unaccompanied by lignites. The latter are sometimes bitumenized. Professor Del Rio has mentioned a similar occurrence. Mr. Murchison also states that in the great copper district, which flanks the west side of the Oural mountains, the copper is wholly in the form of vegetable casts.

Near the Victoria coal mines, which are situated on the left bank of the Nepisiguit, previously spoken of, the vegetable remains occur, partly converted into coal, and partly replaced by grey sulphuret of copper. The same state of things occurs in the rocks at the Joggins, on the Bay of Fundy, within the Nova Scotia coal basin. Mr. Logan states that on the Nepisiguit an attempt was made by the Gloucester mining company, to work the deposit as a copper mine; but the irregular distribution of the organic remains rendered their operations uncertain, and induced the abandonment of them. The bed averages about two feet thick, but in one direction it appears to thin off, from four feet to nothing.†

Coal is mentioned by Captain Bayfield, as occurring at Percé, near the entrance of Chaleur Bay.‡

In Mr. Logan's very detailed section of the coal measures which are displayed in the cliffs of the New Brunswick coast, on the south side of the Bay of Chaleur, it is noted that on many of the coal plants, a very minute convoluted shell is seen, and in the shale is a small bivalve. *Stigmaria ficoides* occurs in abundance and of large size.

II.—*Westmoreland or South-eastern Coal-field.*—Dr. Gesner's second report, in 1840, shows that this coal area is seventy miles in its longest diameter, and that it averages seventeen miles in breadth. "It is by no means certain that coal is contained in every part of the area; but as the outcropping of the bituminous strata has been discovered in a number of situations, it is evident that it embraces vast quantities of coal, and is of the highest importance to the province."

The Westmoreland coal measures, we are told, rest directly upon granite.

III.—*South-western Coal-field, of Sunbury and Queen's Counties.*—By Dr. Gesner's first report of his geological survey, we learn that the coal measures repose upon the mountain limestone, and cross to the west of the river St. John.

* Mr. Dawson, on the Geology of Nova Scotia, February, 1845—proceedings, p. 35.
† Geological Report of Canada, 1st May, 1845, p. 63, 79.
‡ Captain Bayfield, in Trans. Geol. Soc. of London, vol. 5, p. 87.

On the shores of Grand Lake in Queen's county, a company has been incorporated more than 35 years, with a capital of £30,000, to work the coal beds which here lie horizontally a few feet above the level of the water.

An excellent coal mine has been opened on the banks of the Salmon river, which coal is said to be superior to that of the Grand Lake.

The quantity exported is very small, compared with the enormous magnitude of the coal area, as may be seen by the following table.*

In the year 1828, 66 chaldrons; 1830, 70 chald.; 1833, 138 chald.; 1834, 687 chald.; 1835, 3,537 chald.; 1839, 2,143 chald.

No later returns have reached us.

PROVINCE OF NOVA SCOTIA.

"The General Mining Association," as tenants of the Crown and of his late Royal Highness the Duke of York, are lessees "of all the mines and minerals, of every description, in the province of Nova Scotia proper, and in the island and county of Cape Breton."

These coal mines are leased for sixty years, from 1827, at the fixed rent of £3,000 sterling, $14,500, per annum. This fixed rent of £3,000 sterling or £3,333 currency, per annum, conditions for a maximum annual raising of 20,000 Newcastle chaldrons, and fixes a royalty of two shillings currency, for every chaldron beyond that quantity.†

By an arrangement made with the association in 1845, they were allowed to take out 26,000 Newcastle, or 52 London chaldrons, or 65,000 tons, instead of the twenty thousand chaldrons, stipulated for; the fixed rent remaining the same.

The company is generally known under the title of "The Nova Scotia and Cape Breton Mining Company."

The operations of the company commenced in 1827, and have hitherto been confined to the working of *coal* mines and the discovery of *iron ore*. The collieries now open and at work are four in number, viz: the Pictou and Albion in Nova Scotia, and the Sydney and Bridgeport mines in Cape Breton.

The capital of the "General Mining Association" is £400,000—$1,936,000; and they possess fourteen thousand acres of land; besides the right to all minerals and mines within the province of Nova Scotia and Cape Breton.‡

* Statistics of the Colonies of the British Empire, p. 244.

† This extra rent charge of two shillings per chaldron, has frequently been mistaken by American writers for a tariff; or as a writer styled it, in 1846, "an excise duty of 20 cents per ton, for the support of the local government."—U. S. Gazette.

‡ Statistics of the Colonies of the British Empire, Martin, p. 230.

In reciting these details we, as well as our readers, cannot omit to remark the injurious magnitude of such gigantic monopolies as the one before us. In this case it covers an extent of more than *twelve millions of acres*, or three times the size of Wales. It is scarcely necessary to say that its tendency is to impoverish the people; to destroy all energy in cultivating the abundant natural resources of a fine country; to prevent all fair and wholesome competition, to narrow the scope of active and productive industry, and to discourage all individual and general enterprise. On the continuance of such a deplorable system, the rival coal proprietors of the United States, may well found their calculations of a remunerative internal trade in coal, at home, with even greater safety and certainty than on the influence of tariffs and the restrictions of international regulations.

In 1834, another large company was incorporated, under the name of "The New Brunswick and Nova Scotia Land Company," having purchased of the Crown five hundred thousand acres of land, lying in the centre of the province of New Brunswick, at the price of 2*s*. 6*d*. sterling—$0.60 cents an acre. The company are, by act of Parliament, to have the privilege of purchasing lands in New Brunswick, Nova Scotia, Cape Breton, and Prince Edward's Island. They are thereby authorized to mine and work, copper, tin, lead, iron, and all other minerals, except gold and silver, and *except coal and culm*; the two latter being already granted by lease to the general mining association,* in all the above mentioned places except New Brunswick.

Geology.—A small geological map of Nova Scotia was published in 1841, by Messrs. Jackson and Alger. In 1842 Dr. Gesner's first geological map of Nova Scotia and Cape Breton was completed, and issued the same year. In 1845 another map to illustrate the geological papers of Messrs. Gesner, Dawson and Brown, appeared in the Quarterly Journal of the Geological Society of London.

On comparing the first named of this series of illustrations with the subsequent ones, an unusual discrepancy is apparent between them. According to the former, the coal of Nova Scotia is restricted to a couple of spots, embracing an area so minute, as scarcely to be discernible upon the map. Estimating these coal areas by the scale of the plan, they only cover an aggregate area of thirty-three or thirty-four square miles; whereas Dr. Gesner's statement exhibits an area of carboniferous formations of two thousand five hundred square miles; while Messrs. Dawson, Logan and Brown greatly exceed even that area. However, since the provincial surveys have been completed, there can be no longer a doubt on this point, and all original errors arising from early and defective investigations are now fully adjusted.

Dr. Gesner, the first in date, states that from Pictou Harbour, in Northumberland Strait, a *central belt* of coal measures, about six miles broad, runs in a westerly direction, across the isthmus, and passes between the southern flank of the Cobequid mountains and the southern coast of the isthmus, along the Basin of mines; and thence further westward to Advocate Harbour. The length of this central belt is about one hundred miles, and the coal is supposed to rest unconformably on old red sandstone.

These carboniferous beds lap round the eastern extremity and pass along the northern flank of the before mentioned Cobequid mountain range and the Annan Hills, whence they again pass nearly due west to Chignecto Bay, in the Bay of Fundy. All the isthmus north of the line thus desig-

* Appendix to Statistics of the Colonies of the British Empire, No. III. p. 76.

nated, consists of carboniferous strata, forming the northern or Cumberland coal-field. The Nova Scotia coast of Chignecto Bay, runs nearly at right angles to the direction of the coal strata, and presents an admirable section of them, nearly thirty-five miles in length. In making a careful examination of this thirty-five miles of coast, only one unimportant fault was observed. By measuring the horizontal distances between the strata, and making allowance for their inclination, at a number of places, Dr. Gesner estimated the total thickness of the coal measures along this sectional line, at not less than three miles, [between four and five, Lyell;—2¾ miles and 50 feet, Logan.] This is a remarkable fact; unlike, for its magnitude, any other group of coal strata on the North American continent.

The carboniferous series is, thus far, exhibited in the cliffs called the South Joggins; and Dr. Gesner mentions the existence here of nineteen small coal seams, within the horizontal distance of three quarters of a mile. They occur in an aggregate thickness of 1800 feet of strata, and vary in dimensions from six inches to four feet.

Mr. J. W. Dawson, himself a resident of the Pictou coal mines, states that the coast section on the north-eastern side of Nova Scotia, cuts at an acute angle, across two great coal troughs; the one beginning at Pictou on the east coast, and thence stretching to the west along the northern shore of the Basin of mines, [Bay of Fundy;] the other beginning at Antigonish [St. George's Bay,] and thence extending westward to the Shubenacadie river and the southern shore of the Basin of mines, [Bay of Fundy.] These two troughs are separated by a hilly range, composed of igneous rocks, and of disturbed lower carboniferous and silurian or palæozoic strata.*

We ascertain, therefore, from the foregoing outlines, that the coal formation of Nova Scotia occupies three distinct areas, viz.: I. The Northern or Cumberland Region; II. The Pictou or Central Basin; III. The Antigonish or Southern Basin. Dr. A. Gesner adds a fourth district, which probably is an extension of the third. He states that on the south border of the Basin of mines there is an area, near Falmouth and Windsor, of seventy square miles, in which, though coal has not yet been discovered, the ferns, stigmariæ, and other fossil coal plants, which the sandstones and shales of that area contain, sufficiently establish the point that it belongs to the coal measures.†

Large as is the amount of these united areas, comprising between two and three thousand square miles, it nevertheless forms but a fraction of that immense coal formation which occupies large portions of New Brunswick, Nova Scotia, Cape Breton, and Prince Edward's Island.

I. *Northern or Cumberland County Coal Region.*—This embraces the triangular area, which extends from the Cobequid mountain range and the Annan Hills, to the extreme northern boundary of the Nova Scotia peninsula; having the Northumberland Strait to the east, and Chignecto Bay to the west.

In 1845, in a geological report to the provincial government of Canada, Mr. W. E. Logan published a section of the carboniferous strata, within this region, as developed at the Joggins, a continuous cliff, eighty to one hundred feet high, on the south shore of the Bay of Chignecto, Bay of Fundy.

This section is one of the most remarkable ever accomplished, and may be quoted as a model of close investigation, and extraordinary accuracy in developing an enormous series of beds. It comprises the vast group of coal

* Quarterly Jour. Geol. Soc. London, February 1, 1845, J. W. Dawson, p. 26.

† Transactions of the Geological Society, London, 1843. Proceedings of the Geological Society, London, 1843, Vol. IV. p. 178—190.

measures which are displayed along the cliffs, locally named the Joggins, of the sea shore, at Chignecto Bay. This locality, so singularly favourable for taking the strict admeasurement, and constructing an exact section of the vertical thickness of the coal formation, has been frequently alluded to by geologists and travellers. It remained for Mr. Logan to demonstrate by a laborious survey, the true thickness of the whole group, in Northern Nova Scotia.* His section is subdivided into eight principal sub-sections or parts, and these again are further divided into the respective members which compose the mass, separately measured in feet and inches. The extent of the labour may be inferred from the fact, that the whole series consists of no less than fifteen hundred and seventy beds or subdivisions, all minutely described, and making up the aggregate thickness of 14,570 feet 11 inches; equivalent to $2\frac{3}{4}$ miles, 50 feet 11 inches; an amount which far exceeds any thing seen in the coal formation in the other parts of the North American continent, to the southward.

One of the most remarkable circumstances which are brought into notice by the section of Mr. Logan, is the extreme thinness of the coal seams in this portion of the Nova Scotia basin. We collect from an examination of the report, the following stratigraphical summary:

	Feet.	Inch.		Coal beds.		Aggregate thickness. Feet.	Inch.
Subdivision No. 3, consisting of	2134	1	of strata	22	=	5	5
" No. 4, "	2539	1	"	45	=	37	$9\frac{1}{2}$
" No. 6, "	3240	9	"	9	=		10
	7913	11		76		44	$0\frac{1}{2}$

The average or mean thickness of each of these 76 coal seams, is a fraction less than seven inches. The maximum thickness is shown in No. 7 bed of the fourth sub-section, where there are 3 feet 8 inches of coal in a bed 4 feet 6 inches thick; and in the next thickest, we have No. 29, which has 3 feet 5 inches of coal out of a bed 4 feet thick. At the same time, it may be observed, that the greatest thickness of pure coal in any one seam, is only two feet, and it may be questioned whether any one out of the seventy-six coal beds, in $2\frac{3}{4}$ miles of strata, will ever be considered as workable.

Thicker coal beds appear to exist to the eastward of the Joggins. On the Macon river, which falls into Cumberland bay, one seam occurs of ten feet in thickness; and the same, if not another, is seen at river Philip.

Several geologists have noticed the presence of erect trunks of trees in the coal strata of the Joggins, particularly in a bed of sandstone, twelve feet thick. The first notice, probably, being that of Mr. Brown, in Haliburton's "Nova Scotia," in 1829. In 1842, Mr. Lyell saw similar upright trees at more than ten different levels here; all placed at right angles to the planes of stratification. Lithologically, the strata resemble the English coal measures, and those with which the coal and erect trees are associated are more than 2500 feet thick. The grits and shales containing coal plants above these are of prodigious thickness, as we see in Mr. Logan's section just adverted to. Mr. Lyell saw seventeen vertical stumps, varying in height from six to twenty feet, and from fourteen inches to four feet and a half in diameter. The trunks of these trees, which are all broken off abruptly at the top, extend through different strata, but are never seen to penetrate a seam of coal, however thin. They all end, downwards, either in beds of coal or shale; no instance occurring of their termination in sandstone. The

* Rapports sur une exploration géologique de la province de Canada. Jan. 1845.

exterior coating of these trunks is in the state of coal, while the solid interior usually consists of sandstone or fire-clay.

The exact position of all these beds which contain vertical stems of *Sigillaria*, under these circumstances, are exhibited in Mr. Logan's section, which is illustrated by figures of some of these trunks in the position in which they appear on the cliff.

In the vicinity of the highest coal seams, in the series, viz., between seam No. 43 and 44, a twelve feet stratum of arenaceous schist is penetrated by several erect *calamites*, in one instance one of the plants three inches in diameter, extends its roots, and twenty-one others are visible along the face of the cliff, within the space of twenty yards. Their diameters vary from half an inch to four inches. In this sub-section of 2539 feet thick, Mr. Logan enumerates, among the visible organic remains, fifteen *sigillaires* growing erect, and fifty-six *calamites*, standing apparently in their native beds.* Mr. Lyell states that immediately above the uppermost coal seams and vertical trees, are two strata, probably of fresh-water origin, of black calcareo-bituminous shale; chiefly made up of two species of *modiola* and two kinds of *cypres*.†

The Lower Carboniferous Rocks of Nova Scotia, are described by J. W. Dawson, Esq., a resident of the Pictou coal mines, in the Quarterly Journal Geological Society, London, Feb. 1, 1845.

II. *The Pictou, or Central Coal Basin.*—As we have previously explained, this belt of carboniferous strata, stretches from near Cape St. George on the east coast, to Advocate Harbour at the Bay of Fundy, on the west, and follows the north shore of the Basin of Mines. The area embraces the coal mines of Pictou and Albion, and Dr. A. Gesner states that two seams of coal have been discovered in the forest, ten miles north of Truro, and that outcrops of coal appear in the same belt at Jolly river, at Herbert and Economy rivers, and at Parr's borough.‡ Strictly speaking, this district is not wholly separated from the Cumberland region, but is connected for a brief space opposite the east end of the Annan hills, in the vicinity of Pictou. It is, however, most convenient as regards topographical arrangement to treat them as separate districts.

The Pictou region appears to be the richest in coal, yet worked in this province, and it contains the two principal mining establishments of the province.

Mr. Logan's section of this region, made in 1841, is interesting; below are the results of his admeasurements of the carboniferous series; the details we are compelled to omit. Section commencing at the base of the series.

	Feet.
1. Red and drab coloured sandstones, a few coal seams towards the base, the thickness is not stated.	
2. Shales and sandstones with workable beds of coal and iron-stone, - - - - - - - - - -	5000
3. Limestone with marine fossils, - - - - - -	10
4. Coal measures, probably unproductive, - - - -	1900
5. Limestone, with carbonized vegetable remains, - -	10
6. Red and green shales, and red sandstones, - - - -	650
7. Limestone, - - - - - - - - -	20
Total in this part of the coal area of Nova Scotia,	7590§

* Logan's first Geological Report of Canada. Montreal, 1845.
† Lyell, in Proceedings Geol. Soc., 1843. Vol. IV. p. 178—190.
‡ Edinburgh Cabinet Library, No. XXVI. Vol. II. British America.
§ Trans. Geol. Soc. London, 1842.

No. 1, of this section, we presume to be that series which Mr. J. W. Dawson has since investigated and described, under the name of the "*Lower Carboniferous rocks, or Gypsiperous Formation* of Nova Scotia."* This series overlies the Silurian strata, and consists of limestones, gypsum, and soft sandstones; above which are hard reddish sandstones and shales, with limestone; and lastly, red and grey sandstone, shales and conglomerate, with carboniferous plants. Probably these beds pass into the productive coal measures—No. 2, of Mr. Logan's sub-section above.

Mr. Dawson has not been able to ascertain the exact aggregate thickness of the lowest carboniferous rocks; he remarks, however, that in the vicinity of Merigonish, and east of Pictou, the band of carboniferous rocks amounts to 10,000 or 12,000 feet in thickness, all dipping to the north-west at an angle of twenty degrees.

This gentleman discovered a bed of erect calamites in the Pictou coal-field one mile and a quarter west of Pictou, in a bed of sandstone about ten feet thick. They all terminate, downwards, at the same level where the sandstone rests on subjacent limestone, but their tops are broken off at different heights.† This is a repetition of the same phenomena observed, at the distance of one hundred miles, on the shores of Chignecto bay.

Pictou Mine.—At this mine, situated on the West river, there is but one seam, but several miles to the southward, Mr. Logan, in 1841, ascertained the existence of more than twelve coal beds, which are thought to correspond with those in the coal-field of Cape Breton Island.

From notes, made in 1833, we were informed that the main coal seam of Pictou was twenty-nine feet thick: but, at that time, only ten feet of the best quality of coal were worked. It has one seam of slate, five inches thick. The shafts were from sixty to two hundred and forty feet deep, of which two hundred and twenty were below the level of the sea. This is a hard, open burning coal, and is worked with powder;‡ it does not command so high a price in the market as that of Cape Breton. [Sydney and Bridgeport.] The Pictou coal communicates northward from its excellent harbour, with the Gulf of St. Lawrence; while the Cumberland coal passes down the Bay of Fundy, to the southward.

In 1833, the coal was conveyed from the shafts of the Pictou mines, on a railroad of one mile, to a landing place, and from thence about six miles to the shipping. In 1840, a new railroad of six miles, for carrying the coal at once from the pits to the wharfs, was put in operation.§

This coal is stated to possess properties which render it well suited to the various branches of the iron manufacture. It is peculiar, according to Mr. Alger, on account of the abundance of mineral charcoal that it contains; and, for domestic purposes, this is thought to give it an advantage over the Sydney and most other bituminous coals, by preventing it from cementing together while consuming.||

Albion Mines.—Situated on the banks of the East river, in the district of Pictou, and distant about eight and a half miles from the town of that name, a port of safe and easy access from the Gulf of St. Lawrence. A lighthouse was erected on the coast, near the town of Pictou, a few years ago.

The East river is only navigable for the larger craft to within six miles

* Quarterly Journal of the Geological Society, Feb. 1845, p. 26.
† Proceedings of the Geo. Soc., Vol. IV. p. 178.
‡ Journal of the Senate of Pennsylvania, 1833, p. 570.
§ Mining Journal of London, Vol. X. p. 45, and Vol. XII. p. 123.
|| Alger's edition of Phillips' Mineralogy, p. 591.

of the Albion mines; so that vessels arriving for coal, formerly, received their cargoes from barges which loaded at the mines, and were towed down to the deep water by the steamers belonging to the association. In 1840, a railroad was completed, and obviated this inconvenience, as well as the breakage which previously took place by the transhipment.

At the Albion mine is a great collection of coal seams all dipping to the north. The number is stated by Judge Haliburton to be ten, and the aggregate thickness to be sixty feet. The only seam worked a few years ago contained twenty-four feet of clean coal, of which about two hundred and forty tons were raised daily. In 1839, the quantity of coal raised per month, was from five thousand to six thousand tons. Above three hundred vessels, of various descriptions, were loaded here during that season.

There are several shafts at the Albion mine, for raising the coal: one of the engine shafts is four hundred and fifty feet deep.

Quality and Properties.—The Pictou coal is in favourable repute for the use of steamboats. In 1833, the steamer Royal William, of one hundred and eighty horse power and one thousand tons burthen, performed the voyage from Pictou to Cowes with the employment of Albion coal; the trial proving entirely satisfactory. In 1838, the coals for the voyages of the Great Western steamship were supplied from the Nova Scotia mines. They were stated to answer beyond expectation, the quantity consumed being less than the necessary supply of English coal, while the price was lower. The Cunard line of steamers is now supplied with Sydney coal from the depot at Boston.

We have heard less favourable opinions from some persons, yet it has been preferred to the Virginia bituminous coal, which contains more sulphur, and is consequently liable to occasional spontaneous combustion.

The relative value of the Nova Scotia and the Cape Breton coals may be inferred from Mr. Johnson's analyses and experiments.*

		Carbon.		
Nova Scotia Pictou Coal,	Cunard's sample,	60.73	100 parts,	The volatile matter being nearly 27 per cent.
	mining associ'on,	56.98	"	
Cape Breton, Sydney coal,	mean of two spec's,	67.57	"	

We select the following results from the "Report on American Coals," 1844, whereby the practical characters of the British American coals will be seen, and compared with those of other bituminous coals.

Ranks of coals, according to the several practical characters, out of forty-two varieties.	Nova Scotia or Pictou. Cunard's.	Nova Scotia or Pictou. Mining Asso'tion.	Cape Breton or Sydney.	Pennsylvania. Queen's Run.	Virginia. Chesterfield.	Liverpool.
Arrangement in the order of						
Their relative weights,	29	15	35	28	40	33
" rapidity of ignition,	6	9	15	2	13	7
" completeness of combustion,	1	4	7	24	16	19
" evaporative power under equal weights,	30	33	37	2	20	38
" evaporative power under equal bulks,	29	23	35	7	30	36
" evaporative power of the combustible matter,	31	30	39	2	23	40
" freedom from waste in burning,	33	37	5	19	20	2
" freedom from tendency to form clinker,	41	40	13	7	28	11
" maximum evaporative power under given bulks,	30	23	36	10	32	33
" maximum rapidity of evaporation,	4	25	24	27	1	10
	234	239	246	128	223	229

* Report to the Navy Department of the United States, on American Coals, by W. R. Johnson, 1844.

Out of the forty-two varieties of coal which have been experimented upon, thirty-five are from the United States, and seven from British America and Great Britain. The numbers in the table represent the order in which they take their appropriate rank, from one to forty-two. From the care which we know has been bestowed to obtain these results, we cannot hesitate to receive them, in perfect reliance on their accuracy. By taking the four tables of results of evaporative power, the respective coals in the foregoing synopsis, range themselves in the following order of value:

1. Pennsylvania coals of Queen's Run.
2. Virginia coals.
3. Pictou Mining Association.
4. Pictou—Cunard's.
5. Sydney.
6. Liverpool.

On an average, 80,000 chaldrons of coal and 50,000 cords of wood are shipped annually from Nova Scotia to the United States, which return large quantities of manufactured iron.

At present, the iron imported into Nova Scotia and New Brunswick amounts, in value, to £139,000 per annum, while, at the same time, there is not a smelting furnace in any of the British North American provinces, Canada only excepted. This state of things will probably remain until the resources of British America are better known in the mother country; where alone there is capital to improve them. This deficiency of iron works is by no means ascribable to the want of iron ore, which, by the geological statements of Dr. Gesner, is very abundant. There are many varieties of iron ores distributed over this country.

The coal-fields of the Pictou district, and Cumberland county, contain workable strata of the argillaceous oxide and carbonate of iron, known as "clay iron stone." At those places, the ore, the coal for fuel, and the limestone necessary for the flux, are placed side by side. This admirable arrangement, made by Providence, whereby all the materials necessary for the production of iron, are deposited together, is still overlooked in this province, whose metals are imported from foreign countries. All the iron employed for railroads and mining operations, is imported from Great Britain; and having been transported three thousand miles, it is finally thrown into castings, at the very site where thick beds of Nova Scotia ore are seen protruding from the earth; and where a single stratum of coal, thirty-six feet in thickness, is ready to supply the fuel for its smelting and manufacture!*

We may add to the foregoing notice of the prevalence of iron ore, that an enormous deposit of the specular oxide of iron has recently [1847] been discovered at Londonderry Mountain, in Nova Scotia. Dr. Gesner has reported favourably of the ore, and its local position. It is estimated to yield about seventy per cent. of cast metal.

Exportation.—In the year 1836 the quantity of coal exported from Nova Scotia to all parts, was 42,587 tons, the value of which was £38,328 or \$185,507, being 18*s*. or \$4 48 per ton. In 1839 the quantity exported was 67,632 tons.

The General Mining Association now ships from the Albion Mines to the United States from 40,000 to 50,000 chaldrons of coal annually. Ten seams of coal have been penetrated by the workings at the Albion Mines; the united thickness of these coal beds is upwards of 75 feet. The main coal band is no less than 36 feet in thickness—of this, the company only work 12 feet, leaving 12 feet of good coal, and 12 feet fit for furnaces and forges.

* Geology of Nova Scotia, by Dr. A. Gesner. Also Mining Journal, April, 1845.

In 1839, six steam-engines, 100 horses, and 500 men was employed at those mines, and upwards of 48,000 tons of coal were exported to the United States, and to different ports along the coast.

The Province contains about 15,000 square miles. Of that area, there are 2000 to 2500 square miles of coal-field.

"On the coast of Chignecto Bay, the tide rises upwards of fifty feet; and at low water the beds of coal are uncovered by the sea. Upon these beds vessels from New Brunswick and the United States lie aground, and from them receive their cargoes; and as the shore can hardly be said to be inhabited, no notice is taken of such depredations."

"The steamboats that run into Chignecto Bay are propelled by coal *imported from Great Britain;* their keels often pass within a few feet of the coal strata already mentioned, and from which they might be cheaply supplied; but the Mining Association possesses an entire monopoly, which has prevented every kind of mining enterprise in the province; the inhabitants of Nova Scotia have not been permitted to open the earth beyond the depth of the soil, and up to the present hour they are compelled to pay the price fixed by a single company for all the coals they consume. By withholding the coal from the inhabitants of any civilized country, where that mineral is abundantly found, the manufacture of iron and other metals is prevented; manufactories cannot exist; trade will languish, and general industry be greatly retarded. The truth of these remarks is fully proved by the present state of the province—a colony that will never thrive until her resources are liberated from the fetters of unyielding monopolists."* Let these men look at Pennsylvania.

It appears from a memorial or report of a committee of the House of Assembly, in 1846, that twenty of the sixty years of the lease to the association had then expired; and that yet no effort had been made to work a single bed of coal, or other mineral, with the exception of the coal-beds at Pictou and Sydney!

The General Mining Association, in 1847, determined to open a new coal mine in Cumberland county. This establishment will supply New Brunswick and the Nova Scotia ports in the Bay of Fundy, and will shorten the distance for the coal vessels from the United States.

Newer Coal formation, on the eastern part of Nova Scotia, in the district of Pictou.

Mr. J. W. Dawson has described in Nova Scotia, a newer coal formation than the usual old coal formation upon which it rests. In a palæontological point of view it possesses considerable interest, as its fossils show the continuance of the coal flora during the deposition of a series of red sandstones of more recent origin; and also of the co-existence of that flora with terrestrial vertebrated animals.

The older coal measures of the Albion Mines on the banks of the East River of Pictou are, according to Mr. Logan, 5000 feet in thickness; and are succeeded in ascending order by a great bed of coarse conglomerate, which, as it marks a violent interruption of the processes which had accumulated the great beds of coal, shale, and iron-stone beneath, and, as it is succeeded by rocks of a character very different from that of these older coal measures, forms a well-marked boundary, which Mr. Dawson considers as the commencement of the newer coal formation.

The conglomerate is followed by soft reddish sandstone, above which is a bed of grey limestone, supporting a small bed of coal and a few inches of

* Mineral wealth of Nova Scotia, by Dr. A. Gesner, 19th July, 1845, Mining Journal.

under clay; and over these are at least 2000 feet thick of reddish and grey sandstones and shales, in which is another seam of coal, eleven inches thick, with an under clay. In the grey sandstones are coniferous lignites, fossilized by carbonate of lime, and *calamites, endogenites, and lepidodendrons.* Near Pictou, in addition to these, are fossil ferns, *sternbergia,* [Artisia?] and carbonized fragments of wood, impregnated with iron pyrites and with sulphuret and carbonate of copper. In this series also, and near the town of Pictou, is the bed of sandstone containing erect *calamites,* noticed by Mr. Lyell, in his papers on the fossil trees of the Joggins. In the coast section, westward of the entrance of Pictou Harbour, much red sandstone appears, and also a bed of limestone, and a small seam of coal. Some grey sandstones also appear, in which are numerous fragments of carbonized wood, containing sulphuret and carbonate of copper. Proceeding coastwise to Cape John, at the extremity of the Cape is a bed of white granular gypsum, about three feet thick.

Beyond Cape John this newer coal formation skirts the shores of the Gulf of St. Lawrence, to Wallace Harbour.

In the red sandstones, near Tatmagouche, Mr. Dawson had found on a previous examination, a few foot-marks of an unknown animal. They were mere scratches made by the points of the toes or claws, and their arrangement appeared to indicate that the animal was a biped; their form being quite analogous to that of the marks left by our common sandpiper, when running over a firm sandy shore. On a subsequent inspection, a series of foot-marks of another animal was found. In a specimen forwarded to the Geological Society, the tracks were somewhat injured by the rain-marks, which cover the slab. Many other beds in the neighbourhood were observed to be rippled, rain-marked, or covered with worm-tracks; and as such indications of a littoral origin are not unfrequent in other parts of the newer coal formation, it may be anticipated that many interesting relics of terrestrial animals will in future be discovered. Among other fossil remains in the red sandstones of Tatmagouche, Mr. Dawson noticed a fossil plant covered with shells of a species of *spirorbis,* and few small scales of ganoid fishes.

The sections described by the author of the memoir are included in a district extending about fifty miles along the shores of the Gulf of St. Lawrence.

The greater part of the rocks composing the newer coal formation of Pictou, were formerly confounded under the name of new red sandstone. It is conjectured that in other parts of Nova Scotia, this formation will be found to be a well marked carboniferous group. It is not valuable, however, as a depository of coal; but the existence of such a distinct formation, more than five thousand feet thick, in this country, is as interesting as it was unexpected.* The detection of animal tracks on the coal measures is the first instance we have had of the probable existence of air-breathing animals at any period earlier than the new red sandstone.†

Cupriferous Lignites.—In Mr. Logan's published section of the carboniferous strata of the Joggins, lowest sub-section, or No. 8, are noted several beds of mineralized vegetable remains, belonging to the true coal series, which are replaced by grey sulphuret of copper, covered by a thin pellicle of green carbonate of copper. Four seams of these cupriferous lignites occur in this section—within an area or depth of two hundred and six feet.‡ Their aggregate thickness is twenty-one feet. Mr. Dawson describes simi-

* Proceedings of the Geological Society of London, Vol. I. p. 322.
† Silliman's American Journal, July, 1846.
‡ Rapports sur une Exploration Géologique de la Province de Canada, p. 153.

lar instances in what he denominates the newer coal formation, along the gulf of St. Lawrence, or west coast of Northumberland strait.

At the mouth of French river he observed grey sandstones and shales, containing a few endogenites, calamites, and pieces of lignite, impregnated with copper ore. Beneath these are other sandstones and shales, containing, in a few places, nodules of copper glance. These sandstones are often rippled, and contain branching fucoidal marks. On one of the rippled shales Mr. Dawson found foot prints of animals.

Traces of Animals.—In the ripple marked sandstones of Horton Bluff, Mr. Logan discovered footsteps, which appeared to Mr. Owen to belong to some unknown species of reptile; constituting the first indications of the reptilean class known in the carboniferous rocks.

ISLAND AND COUNTY OF CAPE BRETON.

Topographically the coal area of this island is distinctly separated into three fields or basins, which we shall arrange in the following order, according to the geological map of Dr. Gessner:

I. The Sydney coal-field. II. The Southern coal-field.
III. The Western coal-fields.

I. *The Sydney coal-field* occupies the north-east portion of the Island of Cape Breton. It extends along the coast, and is exhibited in the cliffs, from the north of Sydney harbour to Miray bay; and thence inland to the great entrance of the Bras d'or. This portion is generally estimated to contain 250 miles square of workable coal.

The coal of Cape Breton appears to have been known to the early French settlers prior to the discovery of that mineral in Nova Scotia and Newfoundland. The Abbe Raynal is among the first writers in describing the Cape Breton coal, which he says was worked in horizontal beds in the open cliffs. And he adds that one of these coal seams had been set on fire, and burned with great fury.*

The Sydney coal, as a domestic fuel, is by some asserted to be equal to the Newcastle, and is used by the steamers successfully; but the latter commands two dollars a chaldron more in New York and Boston. The reputation of this coal has so much increased its demand of late years, that the town of Sydney has grown into some importance.

The principal coal seam at Cape Breton is about six feet thick, but the roof not being good, the workmen are obliged to leave a part of the coal—at least this was the case a few years ago, and even then they worked out five feet five inches.

The coal is taken up by shafts, 250 feet deep, by steam power. In 1833 it was hauled one and a half to two miles to the landing, and thence conveyed by lighters to North Sydney, five or six miles up the bay. In quality, this coal may be classed among the soft, close burning, bituminous kinds.

Mr. Richard Brown states that "this coal formation is probably the most recent stratified group in the island; and it is certainly the most important, as it furnishes Newfoundland, Nova Scotia, Prince Edward's Island, and the United States, with an abundant supply of coal, equal in quality to the best of that found in the Newcastle district." The coal-field of Sydney, he continues, situated on the N. E. coast of the island, is the only one that has

* History of the Settlement and Commerce of the West Indies, by the Abbe Raynal.

been sufficiently explored to determine its limits. It extends from Miray bay to Cape Dauphin, averaging about seven miles in width, and occupying an area of 250 square miles. As the general dip of the strata is north-east, or seaward, this great area of coal measures is probably the segment only of an immense basin extending towards the coast of Newfoundland.

Mr. Brown estimates the perpendicular thickness of the exposed coal measures, at more than 5400 feet. In this thickness are contained four seams of workable coal, ranging from four to seven feet each, and several small seams of less than two feet.

They contain similar vegetable remains to those of the English coal-fields, in great abundance; and occasionally trunks of trees, from 1 to 2 feet in diameter. There have also been discovered, recently, fishes' scales, with teeth, fins, bones, and coprolites, in bituminous shale and in a thin seam of impure cannel coal.*

A previous memoir from the same gentleman contained a section of the general sequence of the coal measures and gypsiferous formations on the north-western end of the Sydney coal-field.†

We have, besides, in the same publication, November 1846, a description of a group of fossil trees in the Sydney coal-field, of Cape Breton, also by Mr. Brown. One of the most interesting sections of the coal measures, is that afforded by the cliffs on the north-west shore of Sydney harbour, which runs directly at right-angles to the strike of the strata; exposing almost every individual bed, from the old red sandstone, through the overlying carboniferous limestone, millstone grit, and coal measures.

The author states that the total thickness of the coal-measures, calculated from the highest bed of the millstone grit to their abrupt termination on the sea coast, is 1843 feet. These dimensions appear irreconcilable with those previously given, of the same district.‡

The Sydney coal mines are situated on the north-west entrance of Spanish river, or Sydney harbour, which is equal, if not superior, to any in British America, and is accessible in all winds. It is here that the most extensive operations of the company are carried on. The coal is well suited for domestic use, and for steam purposes, being highly bituminous, igniting readily, and leaving but little ash. A railroad which cost forty thousand pounds, conveys the coal, by means of several locomotives, from the pits to a point in the harbour where vessels of any burden can load with ease, and are well sheltered from the prevailing winds. There are fourteen coal seams, above three feet thick each. One of these is eleven feet and another nine feet.

Like the Pictou coal-field, this is interrupted by intrusive masses of trap, but it contains a sufficiency of coal to supply the world for ages.

The Sydney mines are included in the lease by the crown, in 1827, to the general mining association.

Production in 1832,	39,651 tons
1837,	70,000 tons
1844,	50,000 tons

About half of this went to the United States; the remainder for home consumption. The value of this mine, under active management, has always been held to be considerable. The association, it is said, were offered, previously to 1828, £7000 per annum, which is a smaller sum than they could

* Quarterly Journal of the Geological Society of London, May 1845, p. 210, Vol. I.
† Ibid, February 1st, 1845, p. 25.
‡ Ibid, Vol. II. p. 393.

now obtain, if put unfettered in the market. The coal was first opened above sixty years ago, and has continued from that period to be wrought.

Bridgeport Mines are fifteen miles from Sydney. The coal seam worked here is nine feet thick, of which, formerly, but five feet nine inches were worked, the remainder being left for roofing. This coal, which resembles that of Sydney, is conveyed by a railroad near two miles to the shipping place, from whence small schooners convey it to the larger vessels, which approach within a mile; or the schooners take it on, at once, to Sydney. The mines are situated on the south side of Indian bay, 1¾ mile from the harbour.

Cost of mining coal—Pictou.—In 1833, this coal was mined at the cost of 1*s*. 9*d*. the cubic yard; and filling 1*s*. 5*d*.; total, 3*s*. 2*d*. The miner finding powder and the company finding tools.*

Sydney.—In 1833, price of mining, 1*s*. 9*d*. per chaldron of 50 bushels; with 10 a week for rations. Transportation to the landing, 1½ mile, 1*s*. per load, or about 1 cent per bushel.

Table of the production of the Nova Scotia and Cape Breton coal mines, and the quantity sent to the United States, in chaldrons of one and a half tons each, but weighing in general, according to the custom of the trade, 3750 lbs.† Royalty paid in currency £3333.

	1827.	1833.	1835.	1837.	1839.	1844.
Cape Breton, Sydney,	8,776	15,302	14,673	35,154	38,199	50,000
Cape Breton, Bridgeport,	1,325	9,805	8,265	13,121		
Nova Scotia, Pictou, or Albion,	4,000	18,698	16,185	36,697	29,433	
	14,101	43,805	39,123	84,972	67,632	

Island of Boularderie.—This island, which lies to the north of the port of Sydney, is four miles wide and twenty-six miles long, or one hundred and four square miles, and is wholly composed of the carboniferous formation. It was examined in 1843 by Mr. R. Brown, who invariably found beds of gypsum in the lower part of the coal series, between the coal and the conglomerate. It does not appear that any of the coal seams which are exhibited in the natural sections on every side of this island, have ever been worked.

Geologically speaking, this area is commonly included within the limits of the Sydney coal-field.

II. *Southern coal-field of Cape Breton.*—This coal district occupies the area between the Grand Lake, the Gut of Canso, and the Atlantic Ocean, on the southern part of the Cape Breton. It appears to be about thirty miles in length and about six in breadth.

III. *Western coal-field of Cape Breton.*—On Dr. Gesner's map this region occupies about fifty or sixty miles in length, on the south-west coast of the main island, from St. George's bay to Salmon river.

COAL TRADE BETWEEN BRITISH AMERICA AND THE UNITED STATES.

During the discussion of the United States tariff bill of 1846, much anxiety was felt and expressed in the United States, but especially in Penn-

* Senate Journal of Pennsylvania, Vol. II. 1833, p. 570.
† Martin's Statistics of the British colonial possessions, p. 230.

sylvania, as to the effect which the remission of so large an amount of the duty then imposed on the introduction of foreign coals, might have upon her home trade.

It was shown, and may be confirmed by inspection of our own tables, that, while with the 1842 tariff duty of $1.75 per ton, the increase of bituminous coal from the colonies into Boston, its principal market, was, in 1845, sixty-five per cent. over the supply of 1844,—the increase of Pennsylvania anthracite in the same market, and at the same time, was only eighteen and a half per cent. It might, with good reason, therefore, be inferred that, on reducing the duty to about one-third of the sum heretofore paid, the consequence would be a diminished demand for anthracite, and the almost total exclusion of American bituminous coal from the eastern states.

This has not proved to be the result;—for, while the foreign coal trade of Boston, for instance, has remained nearly stationary under a low tariff, the home trade in anthracite has trebled.

It seems to us that there is one view, in relation to a reciprocal trade in coal, which has heretofore been overlooked. Thus, Canada, although just now not a very important customer, is a purchaser of American coal to a certain extent. Thus, again, while the provinces of Nova Scotia and New Brunswick obtain a limited number of customers from one or two American ports in their vicinity, the coal proprietors of Pennsylvania, of Ohio, and ultimately of Michigan, will, in their turn, supply the adjacent provinces of Canada with the fuel of which they are in need. The Colonial government imposes no tariff on this importation, although the American duty is thirty per cent. on what is received in the United States; a tax equivalent to sixty-five cents per ton. As there exists no coal formation in all Canada, along a frontier of more than a thousand miles; as the wants of the people increase; as manufactories occasion new demands with an increasing population; as the recent requirements for smelting within the mining regions call for an adequate supply of mineral fuel, it does appear to us that the Canadian provinces are destined to become extensive recipients of American coal; and to an amount, ultimately, that will immeasurably exceed the amount of Nova Scotia coal which may reach the American Atlantic ports.

In consequence of the reduced duty on coal imported into the United States, an additional impulse was given, towards the close of 1846, to the trade in coal from the British colonies. Several barques of from three hundred to four hundred tons burden each, were, on the passing of the act of Congress of July, 1846, at once chartered in London for this trade. The deep waters of the north-eastern coast allow the largest class of vessels to take in and deliver cargoes of Nova Scotia and Sydney coal, and hence they could bring it at a lower rate than the small vessels which convey the Pennsylvania and Virginia coals; independently of avoiding the heavy charges on the American coal, by railroads and inland navigation.

For four years the admission of Nova Scotia coal had been increasing in the eastern ports, for the iron and other manufactures, for the supply of the Cunard steamers, and for various uses, in the face of a protective duty of $2.25 per chaldron. With a diminished duty, therefore, it is probable a considerable demand for this description of coal will take place in those ports.

1848. The expectation suggested in the last paragraph, has not been exactly realized. That there has been no larger demand for the provincial coal, we ascribe only to the simple fact, that no bituminous coal will hereafter be able to supplant the use of anthracite for general purposes, and especially for domestic use.

COAL TRADE OF BRITISH NORTH AMERICA.

The principal exportation of bituminous coal from Nova Scotia and Cape Breton, is to the ports of Boston and New York.

This coal is sold to the American merchants by the nominal chaldron of one ton and a half, weighing three thousand three hundred and sixty pounds, or forty-two bushels; but it is understood that the large measurement brings up the chaldron to forty-eight bushels; even measure, three thousand seven hundred and fifty pounds. By the tariff of 1842, the duty was levied on the chaldron of thirty-six bushels of eighty pounds, which is, generally, two thousand eight hundred and fifty-two pounds weight. The retailer at Boston sells a chaldron of two thousand five hundred pounds, and sometimes two thousand seven hundred pounds, the nominal price being influenced by the weight. The Nova Scotia ton is considered equivalent to thirty-six bushels, even measure.

The agitation of the tariff subject on foreign imported coal in the United States, brought forward a great many facts in relation to the trade with the British colonies, some of which details it may be useful to preserve; as the prevailing customs of the trade were but little understood out of the immediate market.

Cape Breton, or Sydney and Bridgeport coals, command a higher price, at all times, than the Nova Scotia or Pictou coals.

Price of Sydney coals in 1846, $3.20 to $3.30 per chaldron, delivered on board the vessel. If five hundred chaldrons be taken by one person, and paid for, forty cents on the chaldron, mine measure, is refunded to the purchaser. Sydney coals overrun the Boston measure about eighteen to twenty per cent. No other allowance is made.

Nova Scotia or Pictou coal, in 1846, cost from $3.00 to $3.20 per chaldron. If one thousand chaldrons be purchased and paid for by one person, thirty cents on the chaldron, mine measure, is deducted. The above prices are for ninety days credit. The Pictou coal overruns the measurement about twenty-five per cent.

A large portion of the Sydney and Pictou coals are carried to the United States in British vessels. The American vessels in this trade are generally chartered to proceed to Sydney and Pictou, and back to Boston or New York. In such case, they generally go in ballast. Some vessels are occasionally loaded with American produce, which goes to Newfoundland and St. Peters, and then these vessels come back to the mines and load with coal for Boston, &c. Corn and flour are sometimes carried to Sydney and Pictou for sale, in small quantities, say one hundred barrels of flour and five hundred bushels of corn; though in general the American vessels carry nothing.

The Cape Breton [Sydney and Bridgeport] coal mines are about two miles from the shipping places, by railroad. There is no extra charge for putting coals on board. The Pictou coal [Nova Scotia] is conveyed from the mines by a railroad of about six miles, to the shipping place.

American Tariff on foreign imported coals, by act of Congress, passed in August, 1842 = $2.25 per chaldron of 36 bushels of 80 lbs. each, $1.75 per ton of 28 bushels of 80 lbs. each, or 2240 lbs.

British Tariff, commencing July 5, 1843, by the colonial legislature. Coals—*free*, both import and export.*

Rate of Toll, in 1846, for American mineral coal, passing the Welland canal, 2*s*. 6*d*. per ton, for the whole distance. Sea coal—free.

* Pope's Journal of Trade, 1844, p. 481.

Freight from the mines to Boston. Boston measure;—average, in 1846, about $2.75 per chaldron; in 1847, $2.50 per chaldron. To Providence, $2.87½.

BOSTON COAL TRADE WITH SYDNEY AND PICTOU.

Imports of Cape Breton or Pictou, and Nova Scotia or Sydney and Bridgeport coal into Boston, U. S., in the following years. The purchases are made in Pictou by the large chaldron of 1½ *tons, but the custom-house returns are on the chaldron of* 1¼ *tons or* 2800 *lbs.* [36 *bushels.*] [48 *bushels, even measure.*]

Years.	Chaldrons of 1¼ tons or 2800 lbs.	Tons of 2240 lbs.	Years.	Chaldrons of 1¼ tons.	Tons of 2240 lbs.
1835		17,650	1841		37,536
1836		30,453	1842	21,899	27,374
1837	29,691	37,114	1843	20,184	25,230
1838	26,610	33,762	1844	20,334	25,417
1839.	37,986	47,482	1845	33,628	42,035

The following statement exhibits the comparative cost of Pictou or Sydney coal, delivered at Boston, by the chaldron of 36 *bushels,* [2812 *lbs.*] *and the ton of* 2240 *lbs., under the American tariff duties of* 1842 *and* 1846, *respectively.*

Details.	Under the tariff of 1842, 6¼c. per bush.		Under the tariff of 1846, 30c. per bush.	
	Chaldron of 2812 lbs. [36 bushels.]	Ton of 2240 lbs. [28.7 bushels.]	Chaldron.	Ton.
Mean price of coal per chaldron of 48 bushels, weighing 3750 lbs., [nominally 1¼ tons,] from $3.00 to $3.20, say $3.10, -	$2.32	$1.85	$2.32	$1.85
Freight to Boston, per chaldron of 36 bushels, $2.75, -	2.75	2.19	2.75	2.19
Duty, - - - - - - - - - - - - -	2.25	1.75	.70	.55
Cost, exclusive of any discount or allowances, - - -	$7.32	$5.79	$5.77	$4.59
Retail prices in Boston, in 1846, from $8 to $9, per chaldr.				
Cost of a ton of Pennsylvania anthracite, in Boston, - -		5.75	to	6.00
Current retail prices, in 1847-8, - - - - - -		6.75	to	7.00

Cost of Pennsylvania anthracite, in Boston, as compared with Nova Scotia coal, in 1846.

Price on shipboard at Philadelphia, $4.00 per ton, to 4.37½, red ash.
Freight to Boston, $1.50 to 1.75 " 1.62½, "

Anthracite, $5.75 $6.00

The cargo prices of coals of all descriptions are generally about $1 per ton below the retail prices.

To these charges may be added, as the case may be, insurance 2 per cent., and commission 2½ per cent.

A preference will always be given in the eastern ports, where bituminous coal is required, in favour of the Nova Scotia coal, over that of Richmond, in Virginia, on account of the large amount of sulphur in the latter.

		Per ton. 2240 lbs.	Colonial currency.
New York.—Average cost of Sydney coal, exclusive of duty in 1836, at Sydney and Pictou, - -		$3.60 =	18*s.* 0*d.*
In 1837, " " - -		2.90 =	14*s.* 6*d.*
In 1846, " " - -		3.02 =	15*s.* 0*d.*
In 1844—By the statement of a New York coal importer it appears that the mean price of Sydney coal imported by him, in that city, from the spring of 1842 to the fall of 1844, was, per New York chaldron of 36 bushels, - - - - - -	$3.88 or	3.01	Prices at N. York.
Add the duty of 1842,	2.25	1.75	
Average cost in the New York market,	$6.13	4.76	
Wholesale price same time, from $6.00 to $7.00, say			$6.50
Comparative price of Pennsylvania anthracite, during the same time, in New York, per ton.			
Cost at Pottsville, - - - -		2.00	
Freight and toll to N. Y. - -		2.60	
		4.60	
Wholesale price, from $5.00 to $6.00, - - - -			$6.00
1846—Cost of Nova Scotia coal, with an ad valorem of 30 per cent. - - - - - - - -		2.69	
Freight to New York, - - - - - -		2.00	$6.50
		4.69	

		Per chaldron.	
Price of Pictou and Sydney coal, in N. Y.	1832,	$9.50 =	7.39
	1833,	8.50 =	6.70
By the cargo, $6.50+2.25 duty = 8.75	1842 to 1844,	8.75 =	6.90
	1846,	8.75 =	6.90
Current retail price of anthracite,	1847-8,	=	6.00
" " Pictou and Sydney,	1847-8,	=	6.50

Providence.—The following statement is the result of an actual purchase and sale of a cargo of Pictou coal received in this port, 8th August, 1846.

Cost on board at Pictou, $3.30, from which a discount of 30 cents is allowed, making the cost price of $3.00 per Pictou chaldron.

Quantity, 162 Pictou chaldrons, measuring at the Custom house 7776 bushels = 48 bushels to the chaldron, or 216 chaldrons of 36 bushels each.

Weight of the same, 271 tons, 18 cwt. 2 qrs. 8 lbs. = 607,500 lbs.

Therefore the actual weight of the Pictou chaldron of 48 bushels, was 3750 lbs.

That of the Boston chaldron of 36 bushels, 2812 lbs.

The proportionate weight of 28 bushels is 2191 lbs., therefore there are 28.7 bushels to 2240 lbs.

Cost of the cargo of 162 Pictou chaldrons at $3.00	$4.86
Freight to Providence, $2.87½, on 216 chaldrons of 36 bushels,	6.21
	$11.07
Amount of duty under the tariff of 1842, - - - - -	$4.75
Amount of duty under the tariff of 1846, - - - - -	1.46

	Per Chal. of 2812 lbs.	Per Ton of 2240 lbs.
Cost price of the coal at Providence, under the old tariff,	$7.23	$5.82
" " under the new tariff,	5.80	4.60

Philadelphia.—Aggregate of nine years importation of foreign coals into Philadelphia, viz., from 1833 to 1841.

	Bushels.	Tons of 28 bushels.
Nova Scotia coal, - - - - -	1,204,732	
English coal, - - - - - -	188,532	
	1,393,264 =	43,026
Annual average,	154,607 =	4,780

1841—Importation of Nova Scotia and Cape Breton coal into Philadelphia.

From Cape Breton, Sydney, - -	38,808	
From Cape Breton, Bridgeport, - -	129,401	
Nova Scotia, Pictou, - - - - -	45,221	
	213,430 =	7,622
English bituminous coal, - - - -	31,158 =	1,113
	244,588 =	8,735

1841—Price of Pictou coal on board, in the Schuylkill,

25 cents per bushel, - - - - -	$7.00
Richmond coal, Virginia, 28½ cents, -	8.04
Alleghany coal, 28 cents, - - - -	7.80

	With the Tariff of 1842, per ton.	With the Tariff of 1846, per ton.
1846—Estimated cost at Philadelphia,		
Price charged on board the vessel, at the place of export, $3.37 per chaldron of 48 bush. or 1½ ton.	2.25	2.25
Fair average freight from Pictou to Philadelphia,	2.50	2.50
Duty, - - - - - - - - - -	1.75	.67
	$6.50	5.42

1847—Wholesale or cargo price of bituminous Alleghany coal at Philadelphia, from 18 cents to 20 cents per bushel = $5.00 to 5.60 per ton. - - - - -	5.60
1848—Alleghany bituminous coal, Jan. 1st, 25 cents per bushel,	7.00
Virginia or Richmond, coal do. 22 do.	6.16
1848—Wholesale cargo price current of anthracite, Jan. 1st, in Philadelphia, - - - - -	4.00

Magdalene Islands.—These, according to the Report of Sir J. E. Alexander, Jan. 5th, 1846, are parts of a great coal formation.

Prince Edward's Island, formerly St. John's.—In respect of its geology, this island is, apparently, a continuation of the great Nova Scotia and New Brunswick coal-field, but no mines have been worked here.

According to an official report of Sir J. E. Alexander, dated Montreal, Jan. 5, 1846, Prince Edward's Island is, in fact, one continuous coal-field.

Gypsum, Grindstones, &c., exported from Nova Scotia.—The Nova Scotia and New Brunswick blue grindstone bed, which crops out from beneath the

coal, is forty-four feet thick, and is probably similar to the millstone grit of England. Eighteen hundred tons of grindstones were annually exported from hence to the United States, some years ago, and probably more of late. The price in the United States is from fourteen to eighteen dollars a ton.

Number of grindstones exported in 1832, 19,240 valued at 30s. each = £28,860 = $139,682.

Of *Gypsum*, one hundred thousand tons were exported annually from hence to the United States, the value in 1830 being $119,234.

By returns to a circular, addressed by the Secretary of the Treasury of the United States, in 1845, it appears that there are at this time about 200,600 tons of foreign plaster annually imported into the United States.

This plaster is admitted free of duty, but the amount is exaggerated, for the returns for 1832 give quantity of gypsum exported from Nova Scotia and Cape Breton, as 46,136 tons, valued at 10*s.* per ton, or £23,270, 5*s.* = $112,627. In 1844–5, the official value was reduced to $77,990,*

NEWFOUNDLAND.

The entire western side of this great island, along a space of three hundred and fifty miles, and from forty to sixty miles in breadth, is occupied, according to Mr. Jukes and Sir R. H. Bonnycastle, by secondary and carboniferous rocks. This country has been very imperfectly explored, and the interior is almost entirely unknown. Of the extent or absolute area of coal in the carboniferous region, we are very imperfectly informed. That which is best known is the south-west part of the island; and it has been traced, at intervals, along a space of a hundred and fifty to two hundred miles to the north-east. Some of the points, where coal seams are intersected by the rivers, are known only through the reports of the Red Indians.

The southern part of the coal basin, best known to Mr. Jukes, he states to be about twenty-five miles wide, by ten in length.

Hitherto it does not appear that coal has formed any part of the exports of Newfoundland.†

In regard to the area which is occupied by coal formations we have no information. It is probably not less than five thousand square miles, nor more than 10,000.

Peat.—Large quantities of this fuel exist on the island. Vast tracts of peat-bog were noticed by Mr. Cormack, in 1823, who states also that beneath its surface occur the trunks and roots of trees, much larger than any which are now growing on the island.

Emigration from Great Britain to British America and the United States.—Before closing our statistics of North America, it may not be wholly out of place to insert a statement of the annual number of persons

* Official United States Report, Dec. 3, 1845.
† Martin's Statistics Brit. Emp., p. 269.

who have emigrated hither during a few years past, from the several ports of the United Kingdom.

	Destination.			Destination.	
Years.	British America. Persons.	United States. Persons.	Years.	British America. Persons.	United States. Persons.
1833	28,808	29,109	1842	54,123	64,215
1834	40,060	33,074	1843	23,518	28,351
1835	15,573	26,720	1844	22,923	43,661
1840	32,293	40,642	1846	35,617	
1841	38,164	45,169	1847	100,000	

Emigration from Great Britain during the twenty years from 1825 to 1844, inclusive.

To British American colonies, - - - 551,386 persons.

To the United States, *via* the colonies, - - 569,633 "

1846—The number of emigrants who landed at Quebec and Montreal in 1846, was 32,753; of these, there were Irish, 21,000. Emigrants arriving in West Canada, through the United States, 2,864. Emigrants and passengers arriving in New York from Europe in 1846, being upwards of 300 per day, 115,230. Total emigrants to the United States, arrived in 1846, 158,648.

1847—Of the 100,000 persons that emigrated to Canada in this year, full 25,000 died of the "Ship Fever," either on the voyage, or immediately after their arrival.—"Report of the Montreal Immigrant Committee for 1847."

The following is a statement of the arrivals, tonnage, and passengers, at the port of Quebec from 1841 to 1846, inclusive:

Years.	Vessels.	Tons.	Passengers chiefly emigrants.
1841,	1246	446,642	28,086
1842,	864	307,687	43,811
1844,	1214	458,981	19,698
1846,	1439	573,208	32,903

Tonnage cleared at Quebec and Montreal in 1846, 592,577 tons.
Cleared for the Lower Provinces, 6,558 tons.

Total, 599,135

Arrivals and Tonnage at Quebec to 1st of December in each year:— In 1846, 1439 vessels, 573,104 tons. In 1847, 1178 vessels, 404,485 tons.

Kingston, Upper Canada.—The number of steamers and propellers belonging to this port in 1846, was 115.

HUDSON'S BAY TERRITORY.

ORIGINALLY STYLED RUPERT'S LAND.

Royal Charter and Powers of the Hudson's Bay Company—granted by Charles the II., 2d of May, 22d year of his reign, A. D. 1670.—The extraordinary magnitude of the powers, privileges, and resources of this company being but little known or understood, we have made an abstract of the Royal Charter, for the purpose of exhibiting them.

The title of the company is,—"The Governor and Company of Adventurers of England, trading into Hudson's Bay."

The grant comprises the sale, trade and commerce of all the seas, bays, straits, lakes, rivers, creeks and sounds, in whatsoever latitude they shall be, that lie within the entrance of Hudson's straits; and all the lands and territories upon the countries, coasts and confines of the same seas, bays, &c., that were not already in possession of, or granted to, our other subjects, or the subjects of any other Christian Prince or State; together with rights of fishing therein; and the Royalty of the sea upon the coasts within the limits aforesaid; and all mines royal, of gold, silver, gems and precious stones, within the same limits. "The said land shall henceforth be reckoned and reputed as one of our plantations or colonies in America, called *Rupert's Land*—Prince Rupert being the first Governor thereof: to be held as of our Royal Manor of Greenwich, in the county of Kent, in free and common socage; yielding and paying yearly to us, our heirs and successors, for the same, *Two Elks and two Black Beavers,* whensoever and as often as we, our heirs, and successors, shall happen to enter into the said countries, territories, and regions hereby granted."

It shall be lawful for the Governor and company to make and ordain such reasonable laws, constitutions, orders, and ordinances, as shall appear necessary, and at their pleasure to revoke and alter the same; and they may lawfully impose and ordain such pains, penalties and punishments, upon all offenders against such laws and ordinances, as the Governor and company shall deem necessary or convenient; and the same fines and amerciaments shall and may be made to the use of the said company, without any account, to us, our heirs or successors. They shall have not only the entire and only trade to and from the territories specified, but also the whole and entire trade to and from all havens, bays, creeks, rivers, lakes and seas, into which they shall find entrance by water or land, out of the territories aforesaid, and with all the natives and people inhabiting the same, and with all nations adjacent.

No part of the said territories, nor the islands, havens, ports, cities, towns, or places thereof shall be frequented or haunted by any other of our subjects, contrary to the true meaning of this grant; and all such persons are prohibited from visiting, trading or trafficking in the said territories, upon penalty of the forfeiture and loss of the goods and other things which shall be seized, as also the ships wherein such goods shall be found; and such offenders, for their said contempt, shall become bound unto the said Governor in the sum

C. de Montes
St LAWRENCE
NOTRE DA
CANADA
Restigouche Bay
Anguille
C. Ray
N C E
rth Cape
NEW BRUNS
St JOHN
T O N
Sydney
Miray Bay
C. Breton
Fredericton
Grand Manan
of English Miles
Bay of Islands
Coal River
C. St George
Bay of St George
NEW FOUNDLAND

of one thousand pounds at the least, at no time thereafter to trade into any of the said places or territories.

And we further grant that all lands, islands, territories, plantations, forts, fortifications, factories or colonies, within the scope of this grant, shall be from henceforth under the power and command of the said Governor and company, saving the faith and allegiance due to the Crown; and they shall have power to judge all persons, in all causes, civil and criminal, according to the laws of England, and to execute justice accordingly. And free liberty and license is granted to the said Governor and company to send ships of war, men, and ammunition, unto any of their plantations, forts or factories, for the security and defence of the same, and to grant commissions to the commanders and officers, and to give them power and authority to make peace or war with any Prince or people whatsoever, that are not Christians, in any place where the company shall have factories, forts or plantations, or adjacent thereto. And it shall be lawful for the company to build such castles, forts, fortifications, garrisons, colonies or plantations, towns or villages, in any places within the limits granted, and to send out from England all kinds of clothing, ammunition and implements, necessary for such purpose; and to transport over such number of men, being willing thereunto, as they shall think fit, and also to govern them in such legal and reasonable manner, as the company shall think best; and to inflict punishment for misdemeanors, fines or breach of orders.

They shall have power to seize upon all English which shall sail into Hudson's bay, or shall inhabit any of the countries hereby granted to the company, without their leave and license first obtained, or that shall contemn or disobey their orders, and shall send them prisoners to England, there to receive such condign punishment as the cause shall require.

The company shall have power to examine upon oath all factors, masters, pursers, supercargoes, commanders of castles, forts, &c., touching any matter not repugnant to the laws of the realm. And all admirals, vice-admirals, justices, mayors, sheriffs, constables, bailiffs, and all other officers, ministers, liegemen, and subjects whatsoever, are commanded to aid and assist the said Governor and company, as well on land as on sea, whenever they shall be required.*

This Charter is still in operation.

The boundaries of this vast territory, as may be perceived, are not very satisfactorily defined by this Charter. This point was of very little consequence at that time; but it afterwards proved the cause of very serious and long-continued disputes, between the company and a rival association, called the "North-west Company," which was established in 1783. The union, formed in 1821, between that company and the Hudson's bay company, has greatly enlarged its territorial limits, so that it now claims a kind of proprietorship over the whole of British America, with the exception of the settled provinces or governments.

We have previously cited the Charters of the "General Mining Association," and that of "The New Brunswick and Nova Scotia Land Company."

Area of the British possessions in North America.

The Provinces of the Canadas, New Brunswick, Nova Scotia, &c., is 425.062 square miles.† Territories owned by Great Britain, including the

* Colonial Statistics of the British Empire, Martin, Appendix III.
† McCulloch's Gazetteer.

Hudson's Bay Company's possessions, deducting bays, lakes, &c., 2,574,938. British Honduras in Central America, 62,740. Total, 3,062,740.

The entire area of the United States, Texas, Oregon, and western territories, 2,565,000. Of Russian America, 900,000.*

ARCTIC OCEAN.

Greenland or Gröenland—partly colonized by Denmark, but formerly considered part of North America. A regular coal formation on the east coast of this peninsula was first discovered, we believe, by Captain Scoresby, the limits of whose survey extended from N. Lat. 69° to 72° 30′. Northward of this point, the exploration was continued by Captain Clavering to N. Lat. 76°.

The coal formation is described by Captain Scoresby as corresponding with that which prevails around Edinburgh, and with all the coal-fields of England and Scotland. The fossil vegetation appears to be analogous to that of the European coal measures. The examination of the Greenland coal beds was not carried on beyond Lat. 71°.

Captain Scoresby remarked the prevalence of masses of secondary trap intruding among the coal strata.

Hasen Island, Greenland.—Brown or Bovey coal, in which amber is interspersed, prevails here. In these lignite beds occur the mineral resin called retinasphalt. Beds of peat and turf are also encumbent upon granite.

West coast of Greenland.—Disco Island.—In both these situations, secondary and tertiary formations prevail, although primary rocks are by no means absent. Limestone, containing fossil fishes, and beds of shale and slate, with brown coal and amber, abound. The island of Disco is mainly composed of trap rocks, and the tertiary formations including the lignites referred to. Mineral charcoal is announced as occurring in the island.

Byam Martin's Island.—Secondary or true coal series.—A portion of this island consists of rocks of the primitive class: but there are also secondary formations, among which is a coal-field. Captain Parry has reported that the greater part of the superficial area of this newly discovered island consists of secondary red sandstone, in close proximity to which is the coal. A carboniferous sandstone, for so it appears to be considered, not only in this island but in Melville island, and in various positions which were subsequently discovered further to the south and south-west, belongs to the true coal formation, as in Europe, and other parts of the world. The brick red sandstone, which is described as occurring here, and also seen at many parts of the adjacent American continent by later explorers, and horizontally disposed along the cliffs of Melville and Byam Martin's islands, probably represent the old or the new red sandstone, or portions of both; but the relative positions of these formations do not appear to have been ascertained.

* Commerce and Resources of British America, Hunt's Magazine, Vol. X., 1844.

A fossil dicotyledonous tree was found on the shore of Byam Martin's Island.

Melville Island.—True coal formation.—This is the most westerly point hitherto attained by any exploring expedition from the Atlantic side. It lies in N. Lat. 74° 26′, and in W. Long. 113° 46′; a position where the summer lasts but a few weeks.

Here, an extensive coal formation prevails in secondary sandstone, overlying the carboniferous or mountain limestone. This sandstone contains remains of arborescent ferns, and casts and impressions of the usual coal vegetation. In the specimens collected here that were best preserved from the influence of the atmosphere, the coal possessed a slaty structure; colour, brownish black: after burning, leaves grayish white ashes, and emits no unpleasant smell under the process. Another species of coal was also brought from Melville island. According to the Wernerian nomenclature, this would be denominated *transition glance coal* or anthracite, in contradistinction from the other variety, which held the name of the *first or oldest secondary coal formation.** This so called "transition coal," is associated with a sandstone or micaceous quartz rock containing trilobites, [?] and traversed by whin dykes or trap veins. We much doubt the existence of coal formations of separate ages, as is here indicated, and the narrative of the expedition by no means countenances such a view of the case.

The secondary coal would, of course, be deprived of its bitumen and all volatile matters, in the vicinity of the intrusive masses of trap, as is commonly the case: it would, consequently, assume the appearance of glance coal or anthracite. This bituminous coal of Melville island belongs, according to Mr. Lyell, to the true carboniferous series.

It seems, therefore, to be fully settled, that nearly the whole of this island is composed of horizontal coal sandstone and red sandstone, except at Table Hills, where the carboniferous limestone made its appearance. This latter rock, it has since been ascertained, is extended over a very large space in these northern regions, occupying nearly an equal area to that of the primary rocks. According to the excellent authority of Professor Lindley, the Melville island coal vegetation is decidedly that of the true coal formation, and consists of the usual sigillariæ, stigmariæ, calamites, ferns, &c.

Prince Regent's Inlet.—On the west side of this inlet is the country named by Captain Parry North Somerset; and on the east side is that called by him Prince William's Land; both composed of a magnesian limestone, which is supposed to correspond with the mountain limestone of Europe, and with the metalliferous limestone of the United States. In association with this rock, are other formations which we are led to infer are all of a later origin; also fibrous brown iron ore and a species of brown coal. Above the limestone reposed thick beds of gypsum and a newer slaty limestone. The coal spoken of is probably not so modern as the tertiary.

To the southward of the Inlet, primary rocks occupy the largest areas apparently.

* Professor Jameson's Arctic Geology.

NORTH-WEST TERRITORY.

BROWN COAL FORMATIONS. SUPER-CRETACEOUS STRATA.

Shores of the Arctic Sea.—Dr. Richardson, who accompanied Captain Franklin's expedition of discovery, in the capacity of naturalist, describes much bituminous shale which formed precipitous banks. In many places these cliffs were observed to be on fire; attributable to the great admixture of sulphur in the shale.

Brown coal is more subject to spontaneous combustion than the true coals. The super-cretaceous coal beds, which extend many hundreds of miles in breadth along the upper Missouri valley, were observed by Lewis and Clarke in 1804, and by subsequent travellers ever since, to be on fire in numerous places on the borders of the great rivers. The same phenomena prevail in Australia in coal of the like age.

Tertiary and other Coal formations east of the Rocky Mountains.—In a preceding part of this work, we traced the southern portion of this great area of tertiary coal through the upper Missouri valley, within the United States limits. Commencing at the boundary line of N. Lat. 49, where this formation is full four hundred miles wide, we proceed to trace it in its progress northward.

It follows the general range of the Rocky Mountains in a zone which gradually contracts in breadth to the north. It is intersected by all the great streams which descend eastward from the Rocky Mountains, and the coal seams thus exposed are from one to eight feet in thickness. In numerous places these lignite beds have, from the period of their earliest discovery, been on fire, and in one locality it has continued on fire for more than forty years.

Near Edmonton, on the north branch of the Saskatchewan, Mr. Drummond found beds of a beautiful bituminous coal, which Dr. Buckland, from its peculiar fracture, considered to be tertiary. Captain Franklin saw beds of lignite and tertiary pitch-coal at Garry's island, off the mouth of the Mackenzie river. There occurs an extensive deposit of it near the Babbage river, on the coast of the Arctic sea, opposite to the termination of the Richardson chain of the Rocky Mountains. There were also seen beds of tertiary pitch-coal opposite Herschel island.

On the west side of Great Bear lake, Dr. Richardson discovered strata of brown coal, earthy coal, and bituminous shale and clay, overlying a vast region of magnesian limestone and dolomite, [Iowa and Wisconsin limestone.] He also describes the lignite formation on Mackenzie's river, as lying in horizontal strata, in four seams. It is bituminous, and, when recently detached, is pretty compact, but soon splits into rhomboidal pieces. It burns with a fetid smell, and was found by the blacksmith to be unfitted for welding iron when used alone, but it answered when mixed with charcoal, although the stench it created was a great annoyance. Different beds, and even different parts of the same seam, presented specimens of the fibrous brown coal, earth coal, conchoidal brown coal, and the trapezoidal brown

coal of Jameson. These beds in some places were on fire in 1789 when visited by Mackenzie, and were still burning in 1827.

Beds of lignite were seen by Captain Franklin at the junction of the Great Bear river and the Mackenzie.

Not far from the base of the Rocky Mountains, and ranging parallel between them and the western boundary of the great limestone formation of the north, the scientific explorers traced, at numerous points, coal deposits which varied much in quality, from the brown wood-coal to an excellent pitch-coal, the fractured surface of which is marked with very peculiar concentric semicircular depressions. It is interesting to know that this coal, which would be excellent fuel for a steam vessel, occurs on the coast of the Polar sea, near the Mackenzie, in considerable quantity. It was also traced from the 49th to the 69th degree of north latitude.*

We believe that we have collected and examined all the published details which throw any light upon the coal formations of the extreme north, more especially those which establish the continuity of the immense deposits of the tertiary age. But it would seem probable that coal deposits older than these tertiary lignites, do also appear in these northern regions. Without adverting to the true coal-field of Melville island and the accompanying sandstones which extend from thence to the south-west as far in that direction as Great Bear lake, it appears, on the authority of Dr. Richardson and Captain Franklin, that a formation of the oolitic period exists in one part of the Mackenzie valley, near the junction of Great Bear lake with the Mackenzie; the sandstone strata contain ammonites. These ammonites were referred by Mr. Sowerby to a part of the oolite series, near the *Oxford clay*. With these fossils occur, likewise, carbonized impressions of ferns and coal plants, lepidodendrons, &c. The splitting or separation of the lignite into series of rhomboids as mentioned by Dr. Richardson, we have often observed in the semi-bituminized wood of the Oxford clay, in Europe.

It deserves inquiry, therefore, whether at this place we may not have the equivalent of the carboniferous strata, which form a conspicuous portion of the oolite series in Yorkshire and at Brora in Scotland.

Again, the fossils collected at the point called the Ramparts, on Mackenzie river, were all referred by Mr. Sowerby to the *cornbrash*, another member of the oolite group. At Great Bear lake, certain strata were observed which had a remarkable resemblance to the numerous thin beds of *lias* or alum shale of Whitby. On the border of the Arctic ocean, east of the Mackenzie towards Cape Bathurst, the cliffs offered a singular resemblance to those of the *alum shale* in Yorkshire, upon which the *inferior oolite* rests. Thus, there seems some probability that a part of the oolite series really exists in these latitudes, and that some of the coal seen may be as old as that of Yorkshire; thus forming an intermediate deposit, between the true coal of Melville island, on the one side, and the tertiary coal range on the other.

In the vicinity of the Hudson's Bay Company's Fort called Edmonton, in about north latitude 53°, and west longitude 112°, a seam of coal, of about ten feet in thickness, can be traced for a very considerable distance, along both sides of the river Saskatchewan. Sir George Simpson thus describes this coal. "It resembles slate in appearance; and though it requires a stronger draft than that of an ordinary chimney, yet it is found to answer tolerably well for the blacksmith's forge. Fossil remains are also found here in

* Captain Franklin's Narrative.

abundance; and at the fort there was a pure stone, which had once been a log of wood, of about six feet in length, and four or five in girth."*

Peel River, Rat River, and northern termination of the Rocky Mountains.—This important stream [Peel river,] falls into the Mackenzie from the south-west, in north latitude 67° 42′. The geology of its vicinity and of that of the Rat river, has been sketched by Mr. Isbister. There is little difference in these districts.

Peel river.—Below the alluvium are thick beds of aluminous shale, alternating with which are seen thin strata of brown coal; a formation which seems to be extensively distributed over all the country north of Slave lake. A loose red sandstone prevails in the district west of the Peel river, and is apparently the general underlying rock to these carboniferous deposits. To this red sandstone, succeeds below, a limestone formation, which is not particularized by the author, but is doubtless the same as exists throughout a vast extent of the northern part of America, and perhaps an extension of that in Illinois and Michigan.

The ranges of the Rocky Mountains opposite the newly established post of Fort McPherson, north latitude 67½°, are here dwindled down to a comparatively insignificant elevation: few of the peaks rise above six or seven hundred feet in height. Viewed from the west, they present soft undulating outlines, rising in a series of terraces. The inferior or western ridges consist, generally, of sandstone, while the higher are capped by limestone. As we trace these mountains towards the south, the transition and primitive rocks appear, and they increase in ruggedness and altitude. There are, at one part of the chain, ten of these parallel ranges, which occupy a breadth of from fifty to ninety miles.

North of Rat river, and opposite the mouth of Peel river, the continuity of the main range dies away, and exhibits only irregular ridges and solitary peaks, stretching towards the Arctic Sea. It is observable here, that the succession of formations, rising from the secondary to primary, is from the west to the east; the eastern aspect being the most abrupt and precipitous.†

Extent of the Tertiary Lignite Formation.—Beds of brown coal have been observed to the east and west of the mouth of the Mackenzie, along the borders of the Arctic sea. Whether it be continuous with that observed on each side of Icy Cape and as far as Behring's strait, we have no direct or conclusive evidence. But there seems now no doubt but there is a continuous belt of this formation from the Frozen sea, to near the sources of the Platte, the Arkansas and the Canadian rivers in the United States territory; nearly as low down as north latitude 35, which, following the oblique direction of the range, from point to point, is little short of 2500 miles. How far to the southward this tertiary formation extends is still doubtful: but there is a formation of coal, of some kind, as low as Sierra Verde in New Mexico, in about latitude 32°, and M. Humboldt states that lignite occurs in many parts of New Spain.

The breadth of this belt is but ill defined at the present day. For several hundred miles it probably averages one hundred miles wide, increasing towards the south; but subsequently diminished in that direction; and at the boundary between the British and American territories, is four hundred miles broad. A vast breadth of country between the Upper Missouri and the Platte rivers is overspread by this formation which partially covers the cretaceous beds of Nicollet.

* Overland Journey round the World, by Sir George Simpson, 1847, p. 69.
† Journal of the Royal Geograph. Soc., Vol. XV., 1845.

It is impossible to arrive at any certainty in relation to the superficial area, but we cannot estimate it at less than 250,000 square miles.

Until the final settlement of this matter be effected by more geological evidence than we at present possess, we fear we must leave the question undetermined. Unfortunately, the position is too remote, and the difficulties in the way of investigation are of such a formidable character, that it may be long before this interesting and important question in geology is satisfactorily decided.

Even far to the southward, on ground much more frequently trod, the geology is very partially and obscurely developed. Colonel Long states, that the sandstone which flanks the east side of the Rocky Mountains acquires considerable height and breadth, near the sources of the Missouri, the Platte, and the Arkansas; forming a belt from two to many miles in width, and containing fossils. Dr. James says, that this sandstone "contains organic remains similar to those in the sandstones of the coal formations." This rock is described as rising above the plain, abruptly, like a vast rampart; often highly inclined or vertical; while the strata of the plains [containing the tertiary coal] are horizontal.

Thus, at various and remote points, along the range east of the Rocky Mountains, we have references, more or less obscure, and frequent, of an older coal formation than the mere lignite range which stretches along the plains. Whatever doubt may attach to the presence of the former, there can be little or none as relates to the prodigious extent of the tertiary coal deposit.

Western Territory, beyond the Rocky Mountains.—In the neighbourhood of Fort McLaughlin, in Millbank Sound, lat. 52° 10′ north, coal has been found "of excellent quality, running in extensive fields, and even in dumpy mounds; and most easily worked, all along that part of the country."*

Vancouver's Island.—According to the narrative of Captain Wilkes, United States Navy, coal of good quality is found here, and specimens were collected by the exploring expedition. He remarks, that the Hudson's Bay Company had made trial of it; but owing to its being taken from near the surface, its quality was not very highly thought of.†

Queen Charlotte's Island.—Coal is also found here, according to Captain Wilkes.

* Dunn's History of the Oregon Territory, 1844.
† Report to the Secretary of the Navy, by Lieutenant Wilkes.

RUSSIAN AMERICA.

North of Behring's Strait, Cape Beaufort, is described by Captain Beechy as composed of carboniferous sandstone containing petrified wood and vegetable impressions, and traversed by narrow seams of coal, ranging in an east north-east direction. This coal deposit is doubtless continuous to the northward, as the same navigator traced it at Icy Cape; and lumps of coal were also dredged up, off the coast.

Beyond the Icy Cape, and Point Barrow, an abundance of coal was observed upon the beach. Still further north, at Point Franklin, the surface of the beach was covered with a fine sand; but by digging a few inches down, it was found to be mixed with coal.

The trade of the Russian American colonies appears to be, in great measure, absorbed by China, who gives her teas in exchange for the American peltries, besides other things, to the amount of more than a million of francs, annually forwarded to Moscow. Measures have been lately taken by the Russian American Company, to facilitate the communications between the coasts of Siberia and the Russian colonies of North America. The government proposes to make examinations in the Bay of Aiane, upon the shores of the sea of Okhostk, in the hope of finding a more safe port and of more easy access, than that of Okhostk, for centralizing her commercial operations.*

Respecting the area of the country claimed by Russia on the North American continent, we have seen no estimate.

The extent of the colony of Russian America was estimated by Hassel at 24,000 square miles. M. Kœppen, of the Academy of Sciences of Petersburg, calculates it at 17,500 square miles only. This appears to embrace only what was considered as belonging to the settled part of the territory; but if we take the boundary assigned to the entire Russian claim, that is, all above 54° 40′ of north latitude, and west of 140° west longitude, extending to the Arctic ocean, the actual area belonging to Russia is about 900,000 square miles. Between lat. 54° 40′ and 60°, the Russian American Company possesses on the mainland only a strip, which no where exceeds thirty miles in depth. The rights of hunting and trading over the greater part of this last mentioned area have been lately leased to the Hudson's Bay Company.†

* Compte rendu du Commerce Russe, en 1843.
† Sir George Simpson's Overland Journey, p. 124.

OREGON TERRITORY.

U. S. TERRITORY SOUTH OF NORTH LATITUDE FORTY-NINE DEGREES.

Cascades of Columbia River.—Tertiary Coal.—At about 122° west longitude and 45½° north latitude, Captain Fremont, near the foot of the cascades, discovered in a bluff on the river, "a stratum of coal and forest trees, imbedded between strata of altered clay containing the remains of vegetables, the leaves of which indicate that the plants were dicotyledonous. Among these the stems of the ferns are not mineralized, but merely charred, retaining still their vegetable structure and substance; and in this condition a portion also of the trees remain. The indurated appearance and compactness of the strata, as well, perhaps, as the mineralized condition of the coal, are probably due to igneous action. Some portions of the coal precisely resemble in aspect the *cannel coal* of England, and, with the accompanying fossils, have been referred to the tertiary period."*

These strata appear to rest upon a mass of conglomerate rock. The vegetable fossils collected here were submitted to the examination of Mr. James Hall, who refers them to the tertiary series, and even to a very modern epoch of that deposit.†

In the cabinet of specimens collected by the United States Exploring Expedition, at Washington, are some specimens of lignite or bituminous wood, from Oregon, also of coal vegetation, apparently of the oolite age, or perhaps yet more recent. Among these plants are leaves of dicotyledons, resembling the birch or beech, and with these occur some species of ferns.

Coal has been discovered and worked in Wallamette or Willamette Valley, nearly a hundred miles above Oregon City.

Another locality of an imperfect coal is at twenty or thirty miles up the Cowlitz river, a tributary to the Columbia river, on the northern side. We have been assured that this was the true anthracite, but Captain Wilkes only regarded it as tertiary lignite. Sir George Simpson observed large quantities of this coal on the surface, bordering this river.‡

Fossil Copal, or Highgate Resin—Has been found at the falls of the Wallamette or Wilhamet, a tributary of the Columbia river, Oregon; and on the shores of the Pacific, north of the mouth of the Columbia river.§

* Captain Fremont's Report of the exploring expedition to the Rocky mountains, p. 192, 1843–4.

† Ibid.—Plate III. fig. 14, 15.

‡ Overland Journey round the World by Sir George Simpson.—Phila., 1847, p. 107.

§ Alger's Phillip's Mineralogy.

UPPER CALIFORNIA.

IN THE OCCUPATION OF THE UNITED STATES ARMY, IN 1848.

North Fork of the Platte River.—Coal Field.—North latitude 41½° and west longitude 107½°.—In the precipitous bluffs bordering this river, Captain Fremont observed a series of strata containing fossil vegetable remains and several beds of coal. The position of this coal formation is in the centre of the Rocky Mountain chain, and its elevation is six thousand eight hundred and twenty feet above the sea. In some of the coal seams the coal did not appear to be perfectly mineralized, and in others it was compact and remarkably lustrous. The rock above the third bed of coal, in the lower hill, is a siliceous clay slate, having a saline taste, and there were also noticed thin layers of very fine white salts, in powder.*

There being no specimens brought home from this place, it does not appear what is the actual character of the formation, but it probably belongs either to the tertiary or the oolite period. The number of beds, their thickness, and apparent extent are not mentioned: but the circumstances under which these original observations were made; the impossibility of giving more than a casual and hasty glance at the geology of the country through which the expedition passed, whilst in a state of continual danger and privation, rendered more exact details almost impracticable. This basin or deposit appears to be surrounded by granite.

Green River.—Black's Fork, Muddy Fork, and other tributaries.—North latitude 41½°, extending from 110° to 111° west longitude.

The strata near Green river were observed by Captain Fremont to contain handsome and very distinct vegetable fossils, overlying an impure or argillaceous limestone. Further westward, conglomerate rocks were seen; and, near them at Muddy Fork, occurred strata of fossiliferous rock, having an oolitic structure, and characterized by fossils apparently of that formation or age. Advancing up the stream, alternating strata of coal and clay, with distinct and beautiful vegetable remains were discovered. Coal also appeared occasionally in the hills as the party advanced, and was displayed in rabbit burrows, in a gap through which they passed over some high hills. A portion of the region thus traversed was seven to eight thousand feet above the sea.

The section of coal strata remarked by Captain Fremont consisted of two beds of coal of fifteen inches each, and three others which are separated by an equal number of clay beds. There is an intermediate bed twenty feet thick, which consists of indurated clay, resembling fire clay, with vegetable remains, chiefly of fossil ferns. Mr. Hall has described and figured these

* Captain Fremont's Report, p. 126 and 296—1843–4.

in the appendix to the Report. Having previously compared these fossil ferns with a large collection from the coal measures of Pennsylvania and Ohio, it became quite evident that this formation could not be of the same age. Several specimens were referred to the oolitic coal vegetation of England, and the general character of the other species, and the absence of the large stems so common in the coal period, led to the conclusion that they also belonged to the oolitic period, although the evidence is not entirely positive. For ourselves, we think that the shells would indicate a later origin. One thing appears certain, that the coal plants must be regarded as mostly of new species; and, in this respect, they form a very important addition to the flora of the more modern geological periods.*

Nearly in the same parallel of longitude, but at the distance of one hundred and fifteen miles to the south, strata of bituminous limestone, highly fossiliferous, were discovered by Captain Fremont on the return of his exploring party. The genera of fossils, Mr. Hall thinks, may possibly belong to rocks of the age of those in the vicinity of the coal above mentioned, but the species are all new. No coal was remarked here, in the hurried passage of the travellers, and the intermediate ground was not visited.

All the circumstances which have so far been brought to light, are of an exceedingly interesting character, and lead us to desire a further and more elaborate investigation.

Coal.—It is said that another coal-field has lately been discovered, which, if true, will greatly facilitate the introduction of steam navigation in the Pacific, and be the means of making California one of the most important commercial positions on the west coast of America; particularly, if ever a communication should be opened by means of a canal across the Isthmus of Panama.†

In the spring of 1847, a new coal mine was discovered near San Luis Obisco, north latitude 35°.—There are now three mines within three hundred miles of Monterey; yet coal was sold, in 1846, from an American whaler, at five dollars a bushel.

Asphaltum and Petroleum, occur abundantly in western California.

* Appendix to Fremont, p. 297.
† Life in California, by an American, 1846, p. 224.

TERRITORY OF NEW MEXICO.

AREA ABOUT TWO HUNDRED THOUSAND SQUARE MILES.

Coal is said to occur in the Sierra Verde. Perhaps it is a continuation of the great zone of lignite which stretches parallel with the Rocky Mountains, even to the borders of the Arctic Ocean, and the most northern limits of the American Continent.

Or it may be a continuation of the carboniferous formation which has been noticed by Col. Long and others towards the head of the principal rivers, bordering the plains.

Don Manuel Alvarez, in a letter dated 4th May, 1847, at Santa Fé, and published in a St. Louis newspaper, whilst describing the minerals of New Mexico, says,—"Coal is found in abundance and of good quality, between the Placers, in the Ratons mountains, and in many other places."

Since then, we have received the narrative of the military exploration, from the Pacific to the Missouri, by Lieut. Col. Emory. He describes the occurrence of coal, between Bent's Fort on the Arkansas river, and Santa Fé, to the north and south of the Raton pass. That seen to the northward, at Capt. Summer's camp, is described as an immense field, the seam which cropped out being thirty feet thick. That noticed by Col. Emory was on the banks, and near the head waters of the Canadian river, at about north lat. 36° 50′, on the 7th August, 1847. At present we have no knowledge whether this be true coal or only brown coal, but are inclined to think it must be the true coal formation. If so, it is an extremely interesting geological fact.

UNITED STATES OF MEXICO.

AREA, EXCLUSIVE OF TEXAS, 1,650,000 SQUARE MILES.*

Official estimate of the population in 1842, 7,015,509 persons; of which only one million are whites.

We have met with no detailed geological description of coal on the Mexican Isthmus, nor on the main land; yet there is abundant reason to believe that brown coal, at least, prevails on the east flank of the central mountain range, as well as true coal, near the eastern frontier.

M. Humboldt affirms that coal, and also fossil wood or lignite, are frequently found in different parts of New Spain.†

We know that a bituminous coal region crosses the Rio Grande, above Dolores, into Mexico, after traversing the greater part of Texas, and pursuing the same general range, of south-west and north-east, as the central coal-fields of the United States.

Brown coal traverses entirely the whole breadth of the Isthmus of Panama in a north and south direction, in 8° to 10° of north latitude.

On the 30th April, 1842, and 5th October, 1843, decrees of the President of the Mexican Republic were issued fixing the tariff of maritime and frontier customs. These decrees fix the value in the currency of the Republic, of foreign money, as follows:‡

	Mexican Currency. Piastres.	C.	French Currency. Francs.	C.
The £1 Pound Sterling, (20 shil. of 12 pence each,)	5	00	25	00
1 Franc, (20 sous or 100 centimes,)		20	1	00
1 Marc banco, (16 shil. of 12 pfennings each,)		37½	1	88
1 Réal de veillon, (34 maraoédis,)		05	0	25
One Piastre, - - - - - -			5	00
Réal, - - - - - - -				62½
Centieme, - - - - - -				05

Bituminous Coal on Salado River.—An extensive bed of excellent coal exists at Guerrera or Reveilla, a Mexican town of 4,000 inhabitants, situated on the left bank of the Salado river, one hundred and twenty-five miles above Camargo. It is now (1848) worked by an American company, and promises to be of vast importance, as it removes the principal obstacle to steamboat navigation, the want of fuel, on the Rio Grande into which the

* Mexico, by Brantz Mayer, Secretary United States Legation, 1844.

† The precious metals were at all times the principal source of attraction in Mexico. At the period of M. Humboldt's residence here, there were three thousand (3,000) mines in operation, raising annually twenty-one millions of dollars ($21,000,000) in silver, and two millions ($2,000,000) in gold. Of copper, there was coined at the Mint, from 1833 to 1837, $4,712,000.

‡ Documens sur le commerce exterieur, Mexique, Législation commerciàle, Jan'y, 1844.

Salado empties its waters, at the distance of twelve miles from Guerrera, and eight miles by land. Both these rivers are navigable for steamboats drawing six feet of water. The existence of this bed of coal was made known to Lieut. Tilden, in a recent expedition to Loredo, and a few tons were placed on board the steamboat. It is described as "a hard bituminous coal, of first rate quality," imbedded in sandstone. Silver and other minerals occur in the vicinity.

A coal formation fifty miles in breadth, probably a continuation or contemporary of that of the Rio Salado, crosses the Rio Grande from Texas, into Mexico at Loredo.

A very short distance above Loredo, on the Mexican shore, and within two hundred yards of the Rio Grande, a remarkably fine coal vein, eight feet thick, occurs. It is affirmed to be good in quality, and free from sulphur; burning readily, and applicable to smiths' uses.

In a country where fuel is so very costly, these coal mines must eventually be invaluable. All these mines will, probably, be worked by American industry.

Lieut. Tilden states that at twenty-five miles below Loredo, in a reddish bluff, one hundred feet high, are numerous "petrifactions of roots;" from whence we might infer that it was a lignite deposit, except for the circumstance of their being within the limits of the coal formation, above described.

He speaks, also, of a great abundance of a substance commonly called red chalk or keel, in the vicinity of the eight-feet coal vein, opposite Loredo.

Whatever the geological age of the coal deposits to the southward, it seems at least now fully settled that good bituminous coal prevails as low as 27° north latitude.

Province of Oajuca or Oaxaca.—Peninsula south of the Gulf of Mexico. Coal is stated to be very abundant in this province, which is celebrated for its mineral wealth. We are not informed as to the geological age of this coal. It has often been proposed to form a ship canal or railroad across the Isthmus of Tehuantepec, by which means the minerals of the country will be rendered accessible. The unsettled condition of Mexican affairs will prevent, for some time perhaps, the accomplishment of so important an undertaking.

Province of San Luis Potosi.—In the intermediate neighbourhood of Tampico, abundance of coal was announced, in 1847.

Province of Vera Cruz—District of Acayuceam.—Here are several coal beds, it is reported, but none of them have been worked. They are, no doubt, continuations of those in the adjoining province of Oajuca.*

In the villages of Sayultepec and Moloacan, are fountains of petroleum.

Asphaltum or Chapapote.—In the interior of Mexico, according to a late traveller, "are Lakes of fresh water, where the Chapapote is found, bubbling up to the surface. When washed upon the borders, it is gathered and used as a varnish for the bottoms of canoes. It has a pungent smell, like that of liquid asphaltum, and possesses, I think, some of its qualities.†

* Mining Journal, 14th February, 1846.
† Hunt's Merchant's Magazine, August, 1845, p. 164.

TEXAS.

Now admitted into the North American Union. Superficial extent claimed, 397,319 square miles; but as defined by statute of first Texan Congress, 324,013 square miles. The boundary is not yet settled, next Mexico.*

Pitch Lake.—An announcement has been made of the existence, in Texas, within 100 miles from Houston,† of a small lake that closely resembles the Pitch Lake of Trinidad. It is filled with bitumen or asphaltum, and is about a quarter of a mile in circumference. During the cool months of winter its surface is hard, and is capable of sustaining a person. From November to March it is generally covered with water, which is acid to the taste; from which cause it has been commonly called the "Sour Pond." In the summer months a spring occurs, near the centre of the lake, from which an oily liquid, (probably petroleum,) continually boils up, from the bottom. This liquid gradually hardens, on exposure to the air, and forms a black pitchy substance, similar to that which forms the sides of the lake. It is said to resemble, precisely, the bitumen of Trinidad; and the Texans conceive that, at some future day, it will be valuable for the production of gas for their cities. It burns with a very clear bright light, but gives out a pungent odour.

Coal is now well known to exist abundantly in Texas, although the country has not been geologically examined. There is no doubt but coal prevails at intervals entirely across the country, in a north-east and south-west direction. Its general position is about two hundred miles from the coast.

On the Trinity river, two hundred miles above Galveston, the coal region there was investigated in 1846, and found to be more extensive than was anticipated. A company, under the title of the "Trinity Coal and Mining Company," was incorporated by an act of the Texan Congress in 1840. Both anthracite and semi-bituminous coal, somewhat like the cannel, in appearance, occur here.‡

Mineral coal, in great abundance, prevails not far from the Mustang Prairie. It is also found, accompanied with excellent iron ore, in the vicinity of Nacogdoches. According to report, this coal is abundant, rich, and of a fine appearance.§

Mr. Kennedy, who has taken pains to collect information relative to the

* Map of Texas, published by the United States War Department, 1844.

† Near the Pond, between Liberty and Beamont, and about twenty miles from the latter village. Houston Telegraph.

‡ New Orleans Picayune.

§ Notes sur le Texas. Documens sur le Commerce extérieur. Juillet, 1842.

resources of Texas, although not an original investigator, says, in a work published in 1844, that "in addition to iron, the utilitarian sovereign of metals, Texas possesses coal—the grand auxiliary of the arts which tend to enrich and civilize the world. Coal, both anthracite and bituminous, abounds from the Trinity river to the Rio Grande. The coal on the latter river above Dolores, has been represented, by the agents of the "*Texas and New Ireland Land Company*," [an association broken up by the revolution in 1836,] as of excellent bituminous quality.*

Formations of secondary limestone, with others of carboniferous sandstones, shales, argillaceous iron ore, and bituminous coal beds, are said to occupy a large portion of the interior of Texas. Westward of these occur the inferior and Silurian strata, trilobite limestones, and transition slates. Beyond all, basaltic and primary rocks of the Rocky Mountains arise; while northward is the great salt lake of the Brazos, and the vast red saliferous region traversed by the exploring expeditions of Captain Pike and Major Long, and since made more familiar to us by Mr. Gregg and other travellers.

A bed of coal extends across the Brazos river towards the Little Brazos and the San Andres, down which stream it may without difficulty be transported at high water.

Near the city of Austin, on the eastern border of the Colorado, is a peak, called Mount Bonnell, overlooking Austin, and having a fall of seven hundred feet perpendicular to the bed of the Colorado. This and other hills, although not scientifically examined, are known to contain beds of anthracite coal.

On the Rio Grande, south-west of Bexar, is a great abundance of bituminous coal. The navigation of this river is reported to be free for eight months in the year.†

In many parts of the rolling prairie region, coal, of fair quality, and iron ore have been found; and it is supposed that beds of these valuable minerals extend over a great part of the country.‡

We have received some recent information of the character of the country bordering upon the Rio Grande, as far up as the Presidio de Rio Grande, from the notes of Lieutenant B. P. Tilden.§

On approaching Loredo, within forty or fifty miles, by the course of the river, and extending north of that town, a coal formation is traversed during that distance. Beds of coal are frequently to be seen, as are deposits of nitre and sulphur, and also thick beds of good fire-clay, at the bases of the bluffs. These strata, and the accompanying sandstone rocks, are supposed to be a prolongation of similar strata at Guerrara, on the Rio Salado, to the south-west; as they agree in their range and dip. The writer, who apparently is not very familiar with geological phenomena, does not furnish any further details.

* Texas, its geography, natural history, &c., by W. Kennedy, 1844.
† Report in 1834, to the "Rio Grande Land Company."
‡ McCulloch, art. Texas; and Iken's Texas.
§ Notes on the Upper Rio Grande, by Lieutenant B. P. Tilden. Philadelphia, 1847.

SOUTH AMERICA,

COMPRISING

1. REPUBLIC OF NEW GRANADA.
2. REPUBLIC OF ESCUADOR.
3. REPUBLIC OF VENEZUELA.
4. REPUBLIC OF PERU.
5. REPUBLIC OF CHILI.
6. PATAGONIA.
7. REPUBLIC OF LA PLATA.
8. EMPIRE OF BRAZIL.
9. BRITISH GUIANA.
10. FALKLAND ISLANDS.

SOUTH AMERICA.

CARBONIFEROUS FORMATIONS.

So far as we have any knowledge, the South American continent, even more than that of Africa, is singularly deficient in coal of the carboniferous age. It was long doubted whether, on either of these southern continents, any coal formation existed of an earlier date than the tertiary epoch. In Africa, however, it is now ascertained that true coal exists in more than one position.

In South America, if any exist there, it is probably within the empire of Brazil. Brown coal, of the tertiary age, has been traced through a vast space on both sides of the Andes, but especially next to the Pacific, at intervals, from Patagonia up to Panama. There is reason to conceive that this great chain of tertiary coal deposits, is of the same geological age as that which we have described as existing along a range of between two and three thousand miles of the North American continent. The interval between the tenth and thirty-fifth degrees of north latitude remains almost unexplored; and, with the exception of two or three known points within that interval where tertiary coal appears, we remain without any data wherewith to fill up the vacant space, in reference to coal.

In relation to South American geology, more especially on the Pacific border, we have perhaps received more information from M. D'Orbigny* than from any other naturalist. There are extensive exhibitions of the silurian, devonian, and even of the carboniferous rocks. Carboniferous limestone occurs at Lake Titaca, in Peru. The base of the Moro of Arica is stated to be of the same rock, and the same formation acquires an elevation of thirteen thousand feet to the east and west of the great Bolivian system. In the Chiquitian system, it forms summits five thousand feet high. But in none of these, nor at a number of other points where similar formations occur, has this author ascertained the presence of regular coal beds of the ancient series.

Mr. Darwin, who devoted four years, from 1832 to 1835 inclusive, to the investigation of the natural history and geology of South America, judging from the position of the tertiary deposits which exist on both sides of the southern Andes, entertained the opinion that the primary chain must have had a great elevation anterior to the tertiary period. In Chili, the Cordilleras are divided into two chains. That on the west consists of stratified sedimentary rocks, resting upon granite. The eastern chain is composed of sandstones and conglomerates, which are more recent than the rocks of the western chain, being partly made up of their debris. Mr. Darwin conceives that these eastern formations are of the same age as the

* M. D'Orbigny on South American Geology. Jameson's Edinburgh Journal, 1843–4.

tertiary deposits of Patagonia, Chiloe, and Conception, and that like them they contain brown coal, or lignite and fossil wood. He noticed at one escarpment of the Andes, a wood of petrified trees, in a vertical position. Some of these were perfectly silicified and were dicotyledonous; in others, the wood was replaced by carbonate of lime. Close to this clump of silicified trees, a gold mine has been worked. The latter details are exemplified in a transverse geological section from Valparaiso to Mendoza, and Mr. Darwin expresses his conviction that the granite [now rising into central peaks, fourteen thousand feet in elevation,] must have been in a fluid state since the tertiary group was deposited.*

REPUBLIC OF NEW GRANADA.

Province of Veragua.—West of the province of Panama, coal beds have been discovered, but of their nature and extent little is known. We are assured that this mineral, which appears to be brown coal, is here in great abundance, and in ample quantity for the supply of a large extent of country around. The existence, also, of further deposits in the mountains of the two provinces of Panama and Veragua, is spoken of with some confidence.†

Isthmus of Panama, Island of Muerto, &c.—Brown Coal Formation.—This region was explored in 1841, by Mr. Wheelwright, for the purpose of searching for coal, for the use of the steamers in the service of the Pacific Steam Navigation Company. After giving a cursory examination to the island of Boca Brava, in which there was observed abundant evidence of the existence of coal, a more specific and practical exploration was entered upon in the island of Muerto, [Death] and some outcrops of coal beds were discovered upon the beach, *dipping due west*, at the foot of a small cliff, twenty feet high. The place selected for mining operations offered the greatest facilities, as the steamers could approach within a hundred yards of the shaft. The further presence of coal, in other parts of the province of Panama was, at the same time, ascertained, while this investigation was proceeding.

Muerto is one of the extensive Archipelago of islands which border this coast, and is situated in north latitude 8° 20, and in 82° 8′ west from Greenwich. It is without inhabitants and is covered with a dense forest. No other works were undertaken here beyond the ascertainment of the coal. Respecting that which was experimented on, in the steamer, by Captain Peacock, he reported that it burned freely, leaving a white residuum. He considered its practical value, as compared with English coal, in the proportion of thirteen to eighteen, and stated that it bore a strong resemblance to the Talcuhuano coal, in Chili, and probably might, when mined from a greater depth than that penetrated by this trial, be sufficiently available for steam purposes.

The town of St. David de Cherokee is distant fifteen miles from the

* Martin's Statistics of the British Colonies, p. 144. Also Proceedings of the Geological Society, London, Vol. II. p. 367, 212.

† On the union of the Atlantic and Pacific oceans, at or near the Isthmus of Panama. J. A. Bryan, 1846.

opening of which we speak, and is about forty miles due south from the fine harbour of Boca del Toro, in the Atlantic. At the latter place coal of precisely similar character to that of Muerto was known, prior to these explorations. At St. David de Cherokee, and at various intermediate points, this coal also prevails. Thus, from the best information attainable, Mr. Wheelwright was led to the conviction that a coal area, of undetermined dimensions, stretches entirely across the Isthmus of Panama, in this parallel at least, and intersects it in the 82d degree of longitude.* It is generally admitted that this coal, like that of Talcahuano, is not older than the tertiary period, but the parties immediately concerned in these investigations did not pretend to any geological skill. If Mr. Wheelwright's views are correct, that a desirable route might be found for a canal, or even for a good road, from Boca del Toro, on the Atlantic, to Cherokee on the Pacific, the distance being only forty miles, and the harbours at either end being excellent, it would present, among other singular features, the remarkable circumstance of passing from ocean to ocean, through a continuous coal formation.

Island of Santa Clara.—In a correspondence of the governor of Guayaquil it is announced that coal of good quality can be obtained.

Santa Fé de Bogota.—Coal occurs abundantly on the south side of the city, and even within the limits of the city itself. This fuel is reputed to burn extremely well, and to give out a great heat. We have received this information from a resident of Bogota, familiar with the use of this combustible. A specimen of this coal has been presented to the cabinet of the Geological Society of London. From the character of the fossils which accompany the formation in which the coal is imbedded, it evidently belongs to the cretaceous period, and probably is of the age of the Gault of England. These fossils have been figured and described by Professor Forbes;† and, at an earlier period, similar fossils from the same locality, by Von Buch. They appear to have a strong agreement with the cretaceous fossils first brought by Lewis and Clarke; subsequently by Mr. Nuttall,‡ and yet more recently by Mr. Nicollet, from the cretaceous beds of the Upper Missouri Valley.§ It seems therefore, not improbable that the formation of Bogota, containing wood coal, is about the same geological age as the formation, containing cretaceous fossils, with thin seams of coal, and petroleum in Upper Missouri.||

Province of Choco.—Near the shores of the Pacific, fossil wood abounds, mixed with rolled fragments of basalt and greenstone. This deposit is celebrated for containing gold and platina.¶

The bitumen of Murindo, near Choco, is of a brownish black colour: soft; and has an earthy fracture. It has an acrid taste; burns freely with a smell of vanilla, and is said to contain a large quantity of benzoic acid. This arises, apparently from the decomposition of trees which contained benzoin.**

In this province, coal, so called, is found at an elevation of seven thousand, six hundred and eighty feet, which is about the same level as the coal of New Mexico, of Upper California, and of eastern Oregon, in the northern continent.

* Wheelwright's Report on the Coal Mines on the Isthmus of Panama.
† Quarterly Journal Geol. Soc. of London, May 1, 1844, p. 174.
‡ Recognized and described by Dr. S. G. Morton in 1829, and in Silliman's Journal, 1830.
§ Described by Dr. Morton in Proceedings Acad. Nat. Science, October, 1841.
|| Harris, in Proceedings of the Academy, May, 1845.
¶ Humboldt's Personal Narrative.
** Dr. Ure's Dictionary of Arts, Mining, &c.

REPUBLIC OF ESCUADOR.

In the environs of the city of Guayaquil a considerable deposit is said to occur of a new species of resinous mineral, which Mr. Johnson, to whom the specimens were submitted, gave the name of Guayaquillite. Two varieties have been examined, and they have been declared to be of organic origin.*

REPUBLIC OF VENEZUELA.

Island of Margarita.—A vast abundance of mineral pitch flows out at various points.

Gulf of Cariaco.—At the Punta d'Araya, at Cape Cirial, and near Cape de la Brea, M. de Humboldt observed a stream of Naphtha, issuing from mica slate, containing garnets and cyanite. A continuation of the same phenomena is repeated in all the large West India Islands, from Trinidad to Cuba, where the bitumen appears chiefly to exude from magnesian and modified rocks. M. de Humboldt considered it a singular circumstance that this spring, the produce of which covers the sea to a great extent, should issue from mica slate: as all others, he observes, belong to the secondary class.†

Porto Cabello.—About fourteen miles south of this place and seventy miles from Caracas, a body of what was termed excellent coal was discovered a few years ago. Whether this be a deposit of brown coal, or a bed of solid bitumen or asphaltum, like the chapapote of Cuba, we have no information. We should rather infer the latter, reasoning from the vast amount of bituminous matter that prevails along the northern border of the South American continent, and the great abundance of the same substance in nearly all the West India Islands.

Maracaybo.—Compact mineral pitch, like that of Cuba, and copious streams of petroleum, occur opposite the city and on the borders of the lake. The petroleum is employed here, as at Havana, for paying the sides and bottoms of vessels. Towards the north-east margin of this lake, which is two hundred and fifty miles in circumference, is a remarkable mine of asphaltum, [pix montana,] "the bituminous vapors of which are so inflamma-

* Philosophical Magazine, Nov. 1837.
† Travels and Researches of Alexander Von Humboldt, 1799.

ble, that, during the night, phosphoric fires are continually seen; which in their effect, resemble lightning. They are more frequent during times of great heat than in cool weather, and go by the local name of 'the Lantern of Maracaybo, because they serve both for lighthouse and compass to the Spaniards and Indians, who, without the assistance of either, navigate the lake."*

Magdalena River.—According to M. Bousingualt, bitumen prevails along the margin of this valley.

This naturalist, who has published a dissertation on bitumen, shows that the immense reservoirs of mineral pitch, which exist on the northern shores of New Granada, on the banks of the river Magdalena, at Payti in Colombia, and upon the shores of Peru and Venezuela, have a geological position precisely similar to that in which we find bituminous impregnated sands in Europe: that is to say, in formations which we must refer to the super-cretaceous group.†

REPUBLIC OF PERU.

Cerro Pasco.—The Director general of the mines belonging to the Republic of Peru, has drawn up a memoir on the coal-fields of his district.

Near to Cerro, he informs us, from four to ten leagues, there are numerous beds of fossil charcoal, of which the chief deposits, near Raucas, are of very good quality, and are several leagues in extent. He has found in these coal-fields a considerable quantity of yellow amber, but could not discover any impressions of the remains of plants or animals. This coal is used in heating steam engines, &c.‡ We infer from this concise yet decisive statement that the deposit is of tertiary age.

In the immediate vicinity of the celebrated silver mines of Cerro Pasco, at an elevation of 14,278 feet above the sea, coal, "of all descriptions," is found in abundance. This convenient supply of fuel is of particular importance to the extensive population of the city. There are here, also, numerous beds of fossil charcoal, of a quality that may be used for heating steam engines, and for the like purposes.§

Of the geological circumstances which attend the position and characterize the age of the coal alluded to, we are uninformed. It does not appear to have been examined by the scientific gentlemen who were attached to the United States Exploring Expedition. From the private narrative of Dr. Pickering, with the perusal of which he has kindly favored us, we perceive that the plateau of the Cordilleras, including the silver mines and the

* McCulloch—Geographical Gazetteer.
† Philosophical Magazine, 1837.
‡ Annales des Sciences Nat., 1829.
§ Smyth and Lowe's Narrative of their Journey from Lima to Para, 1834.

highest peaks, consist of sedimentary rocks. He describes these as consisting of the series which ascend from the lias up to the cretaceous period, inclusive; and he properly suggests whether the coal be not a lignite, rather than a true carboniferous formation? In this respect he is no doubt correct. We have ourselves seen casts of what appeared to be tertiary fossils, from hence, and indeed from the height of 14,000 feet above the ocean.

There are a few specimens among the collection of the U. S. Exploring Expedition, in the Washington collection, of slaty coal slate, and some thin flakes of impure coal, from Peru; but the locality is not stated.

On the western slope of the Andes, opposite to Truxillo, Lieut. Maw observed what he considered a seam of coal. This might perhaps be a continuation of the Cerro beds.*

Coal is said to be prevalent in various parts of the country, at the distance of from two to seven leagues around Pasco. The price is one real for an araba, which might be much reduced if the business were properly attended to.†

Asphaltum, of Coxitambo in Peru. This substance, which may be considered the type of the species, has been carefully submitted to analysis by M. Bousingault. It has a fracture which is eminently conchoidal, and possesses a high degree of lustre. Specific gravity, 1.080. Carbon, 75.0. Hydrogen, 9.5—Oxygen, 15.5, per cent. The residuum, after burning before the blow pipe, was found to be 0.16 only.

REPUBLIC OF CHILI, OR CHILÉ.

Regulations, made in 1842, as to money, weights, and measures in Chili, and their corresponding values and denominations in French and English standards.

	Denominations.		
	Chilian.	French.	English.
Money, . .	1 Piastre = 8 rials = 100 cts. Silver rial, 12½ cents, Cent,	5 fr. 40 cents, 0 67.5 0 05.4	
Linnear measure,	National vare,	0 metre. 836	Metre. Yard, 0 914 Foot, 0 304 Inch, 0 025
Superficial measure,	Square vare,	0 metre, sq. 6,987	Sq. inch, 0 0006 Sq. foot, 0 0929
Liquid measure,	Arrobe = 9 gallons, Bottle—ordinary, 1 Gallon, 1-9th of an arrobe,	34 lit. 0 65 0 841	Lit. 1 gallon, 3,785 1 Pint, 0 473
Measures of weight,	1 Quintal = 4 arrobes, 1 Arrobe, 1 Pound = 2 marcs, 1 Ton = 2000 lbs.	46 Kilogrammes, 11 Kilogrammes, 0 K. 460 920 Kilogrammes,	100 lbs. 25 lbs. 16 oz. 2000 lbs.

* Lieut. Maw. Descent of the Amazon river.
† Macgregor's Progress of America, Vol. I. p. 951.

Tariff of 1844, *fixing the official values of imported articles in Chili. Stone coal is chargeable as follows.**

	Values.	According to value.	Specific duties.
	Piastres. Cents.		Piastres.
Chilian Unities, per the Quintal,	0 40	20 per $^o/_o$	0 38 cents.
		Duties ad valorem.	Specific duties.
French Unities, per 100 Kilogrammes,	4 fr. 70 cents.	20 per cent.	0 fr. 94 cents.
English Unities, per Ton, . .	£2 0 0 =	20 per cent.	£0 8 0

An exploration of the coal-beds that exist so abundantly in Chili, and the other republics of South America, has been made by some of the most scientific engineers, miners, and geologists of that continent. The account so far given by them, is most satisfactory. It appears certain that these countries will be enabled to supply themselves with fuel of a superior quality to the wood fuel. Arrangements are making for working some of these mines, and for constructing a railroad from the great commercial port of Valparaiso to the capital of Santiago, a distance of about 135 miles. We await the reports of these scientific investigators.

Tertiary or Wood Coal Formation of the Chilian Coast.—Talcahuano, Arauca, Chiloe, &c.—In making arrangements for the introduction of the South Pacific steam navigation, it was a primary—indeed, the most essential—point, to ascertain the existence on the west coast of South America, of a combustible suited for the purposes of steam. That a certain description of coal prevailed in Talcahuano, 36½° south latitude had been ascertained several years previously, although its properties and amount remained uninvestigated.

In 1834, Mr. Wheelwright, subsequently superintendent of the company's affairs, in that quarter, made a voyage to the port of Talcahuano and obtained samples of the coal, which, on experiment, seemed adequate to the object required.

In January 1841, the coast between Valparaiso and Talcahuano was hastily examined, and satisfactory evidence was at once obtained as to the presence of a vast continuous strata of this coal. Previously to this, Mr. Wheelwright had been furnished with samples of a description of anthracite, from the Cordillera of the Andes; probably from the metamorphic secondary strata there; but it was in too remote a position to be made available. He also received, as coal, a mineral pitch or asphaltum, from the province of Piura.

On landing at Talcahuano, Captain Peacock and Mr. W. proceeded to the Moro, a range of hills in the vicinity of the town, and found seams of coal, visible in the broken cliffs. Heretofore this fuel had been simply taken from the surface, and no subterraneous mining had been attempted. This work was now commenced. On examining the eastern and northern sides of the bay, extensive coal strata appeared; not differing, it was judged, from that which had been experimented upon. The result of these researches appeared to demonstrate the prevalence of continuous coal beds along that entire section of Chilian coast. About forty labourers were set to work, and forty tons of the coal were sent to Valparaiso on trial.

In order to ascertain the most favourable positions for a mining establish-

* Documens sur le commerce exterieur, Dec. 1844, Paris. Chili is suppósed to be the only American state, formerly subject to Spain, whose commerce has increased, since the separation from the mother country.

ment, it was determined to explore the coast of Arauca, and to proceed as far south as the island of Chiloe, which extends to south latitude 43° 58'.

Coal mines had for some time been opened near Conception, and had already become a considerable article of trade and consumption at Valparaiso.

Captain Fitzroy, R. N., found it in great abundance at the mouth of the Laraquita, where it was also subsequently examined by Mr. W. Its appearance was similar to that of Talcahuano; the formation being decidedly the same. Seams of similar coal were traceable, even from the vessel, in the cliffs of the coast along which the steamer passed, on the voyage; and no doubt remained of the continuity of these deposits, to a very great extent. Passing Arauca, the party proceeded on to Valdivia, and up the river, about eighteen miles, to the town. Here were obtained samples of the same kind of coal; but the place was considered too distant to suit the required purposes. On arriving at Chiloe, researches were commenced. No seam of coal was, at first, observed in situ; although large pieces were picked up; indicating its existence in the neighbourhood of San Carlos.

An experiment made on this fuel, during this exploring excursion of the steamer Peru, showed a comparative consumption of thirteen tons of English coal to sixteen tons of the South American; a result which was considered fully satisfactory. It was further determined, that the influence of the latter upon the fire bars and boilers was favourable: that it made no clinkers, and that the residuum lay lightly upon the bars, without adhering in the slightest degree. On her second voyage, the Peru steamed fifteen hundred miles with this fuel; which fact seems calculated to set at rest all doubts and fears, as to its practical purposes. The seam from whence this supply was derived, has a floor, composed as usual, of shale or indurated clay—fire clay—and a roof of carboniferous sandstone. About five thousand tons were mined, at an expense of about fifteen shillings=\$3,65 per ton: a cost which, as may readily be supposed, would be materially diminished during subsequent operations, and by later improvements and experience in the manner of working.

Already this Talcahuano coal has been worked to the depth of more than a hundred feet, and, at the last report, a shaft was being sunk to reach a lower seam which was thought to be of a more firm and compact quality. Machinery, shops, railroad, mole, and breakwater have been constructed, and the ships of the company were employed in transporting the coal. Although these explorers made no pretension to geological knowledge, they express a passing opinion of "the evidently modern formation" of this coal.*

In 1825, Captain Beechy, R. N., made some trial of this fuel, or rather of that which was supplied to Conception; and, as we were prepared to learn, pronounced it to be of inferior quality, and fit only for the forge. He states that the beds occur in a *red sandstone* formation, and that the coal, at that time, sold for nine dollars a ton.† The correspondent of a Boston paper, evidently of very slender scientific attainments, describes the Talcahuano coal as much resembling the English cannel. Recently its cost, including the putting it on board the steamers, has been only \$2.50 per ton; a great saving over the price of English bituminous coal, which used to be brought out to these ports at \$10.00 per ton. At Penco, near Valparaiso, an inexhaustible supply of similar coal is now attainable.‡

* Report on the Mines and Coal of Chilé, by W. Wheelwright, 1843.
† Voyage to the Pacific, 1825.
‡ Boston paper, 1841.

In a communication in Silliman's Journal from Mr. Wheelwright, prior to the report to which we have adverted above, he merely adds that the coal of which he had mined several thousand tons, was of excellent quality—a phrase of universal application—and that, "in fact the whole southern country is nothing but a mine of coal."*

Volume I. of the Proceedings of the Academy of Natural Sciences of Philadelphia, contains a description of a specimen of the Arauca coal, by W. R. Johnson. He observes that "in external appearance it is nearly related to many of the richest bituminous coals of America and Europe." His analysis appears to confirm this view; for we know of no lignite which contains such an amount of carbon as this; being no less than 67.62 per cent. The greater part of the mass is represented as "of a dull or pitchy black colour. Its locality is said to be in the province of Arauca, thirty miles south of the Rio Bio river."†

In some statements made in 1845 by practical operators at Valparaiso, we observe that they complain that the coal of this country is not adapted for copper smelting, "in as much as it contains too much sulphur and iron;"‡ and coal for that purpose has been brought out from England, at enormous expense. The tertiary deposits at Chiloe and Conception were examined by Mr. Darwin, and are described as composed of beds of sandstone and carbonaceous shale without shells, but containing many silicified trunks of dicotyledonous trees, and alternating with beds of lava.§ In 1844 there were upwards of twenty coal mines open in the neighborhood of Conception.|| In 1845 a railroad was projected from Valparaiso to Santiago. The plan is recommended on account of the scarcity and extreme dearness of carbonic fuel, arising from the insufficient inducements to work the extensive coal beds of the interior.¶

The reports, in 1846, of the progress of Talcahuano coal mining, are not equal to the anticipated results; but we are at the same time informed that the South Pacific Mining Company, having exhausted their first mines, have struck another richer seam, which promises to produce more coal than the steamers can require. It is destined, perhaps, to similar results.

Importation of English Coals into Chili.—In the year 1845, 15,149 tons: in 1846, 8,864 tons.

The indigenous coal in the vicinity of Conception, still continues an object of research. From information which has reached us from Valparaiso, towards the close of 1847, it appears that new mines are occasionally opened in that country. At Tulcahuano, a new seam of four and a half feet was proved. In the tide-way of Penco they are working a bed, at some two hundred yards from the beach, and have cut, in vertical depth, ten feet, without passing through the coal. A third seam has been opened at Perales, on the road to Conception. Altogether, they speak of five new mines, and commend the quality, of course, in the usual manner.

* Silliman's Journal, July, 1842.
† Proceedings Acad. Nat. Science, Phila., May 18th, 1841.
‡ Memorial of Copper Smelters, 1845.
§ Proceedings Geol. Soc. London, Vol. II. p. 211, 1835.
|| Niles's Register, 1845.
¶ Mining Journal, Nov. 1845.

PATAGONIA.

A great southern tertiary formation has been described by Mr. C. Darwin, forming extensive groups on both sides of the chain of the Andes. These appear to be the prolongation of the series which is so largely displayed in Chili. Mr. Darwin thinks that the tertiary deposits of Patagonia may be separated into distinct periods, as they have already been done in Europe, and subsequently in North America. In S. Lat. 50,° and elsewhere, he found fossil shells of this period, with bones of the mastodon, the megatherium, and five or six other quadrupeds. Little is said by the author respecting beds of lignite, which are so abundant in higher latitudes.* We are not informed whether the coal range on the eastern flank of the Andes corresponds in geological age with that on the western side.

Tertiary Lignite range of South America.—From the evidence, incomplete as it is, which has been adduced in the foregoing pages, it will be seen that a vast belt of tertiary deposits, which contain brown coal and lignites, occupies the larger portion of the countries bordering upon the Pacific Ocean, from N. Lat. 10° to at least as low down as S. Lat. 50°. The intervals to which our information does not extend, or remain as matters of inference, are the south-western portion of Colombia, the southern part of Peru, and the northern part of Chili; but if the tertiary strata which are described as flanking the Cordilleras are coextensive with those regions, as is generally supposed, the whole length of the tertiary range is scarcely short of that of the entire continent. At any rate, we think we do not exceed probability in suggesting two thousand five hundred miles as the aggregate length of the tertiary formation, in the greater part of which, we are informed, lignites abound. Looking to the northern continent, where a similar zone has been traced for nearly the same distance, and following the same range, we cannot but be struck with the contemplation of this extraordinary development of a single member of the geological series.

REPUBLIC OF LA PLATA, OR ARGENTINE REPUBLIC.

Until of late years the existence of mineral coal in La Plata had not been suspected, nor can we, even now, speak with certainty as to that fact. Along the Cordillera, bituminous shale and indications of coal are affirmed to be abundant; and it is also said that there are extensive beds of coal in the

* Proceedings Geol. Soc. of London, Vol. II. 211.

extreme south-west angle of the country.* These are probably not older than the tertiary period, and form part of the great zone of that formation which we have already indicated. Mr. Darwin made some geological examination of this part of the Andes, and along the Rio Negro, between the years 1832 and 1835. He also crossed from the Rio Negro to Buenos Ayres, by Sierra de la Ventana, a chain almost unknown to travellers. The tertiary formation occupies a wide area in the south-western part of the country.†

EMPIRE OF BRAZIL.

It is still doubtful as to the presence of coal here. Specimens of coal were exhibited in 1845, which were the production of the Isle of Santa Catherina, S. Lat. 27°, and of the continental part of the province of that name. The examination to which these coals have been submitted, appears to leave for Brazil, at least for the present, small hope of drawing from her own soil the essential combustibles for her steam navigation and industrial purposes.‡ Much, however, remains to be effected ere we can arrive at a knowledge of the vast regions in the interior of this country. This may yet be accomplished in the course of a few more years. An English company has been formed to establish steam navigation up the Amazon river and its tributaries, to form settlements and to commence mining operations. The Amazon river alone can be navigated over two thousand miles; and it is proposed to effect a junction between this river navigation and a railroad to Arica, in Peru. This object is patronized by the governments of Brazil, Bolivia, Escuador, and Peru.§

M. Karsten has furnished two analyses of coals, said to be the production of Brazil. We give the results, and think that they, or one of them, may have been derived from the extreme western limits of the empire, and may probably belong to the brown coal series.

Specimen 1.		Specimen 2.	
Carbon,	57.90	Carbon,	38.10
Volatile matter,	40.50	Volatile matter,	33.50
Ashes,	1.60	Ashes,	28.40
	100.00		100.00
Specific gravity,	1.289	Specific gravity,	1.483

* M'Culloch, Geographical Dictionary.
† Proc. Geol. Soc. of London, Vol. II. 211, 367.
‡ Documens sur le Commerce exterieur, 1844–5.
§ Mining Journal of London, Aug. 2d, 1845.

A small quantity of Coal is annually imported into this country from England, as shown in the following table: the increase of late years is considerable.

Years.	Tons.	Declared value.	Current prices per ton at Pernambuco.			Par value of £1 sterling in London, 7 milreis, 117 reis of Rio Janeiro.
			Years.	French.	English.	
1831	840					
1833	1,863					
1840		£ 9,718				
1842		£17,552		fr. cts.	£ s. d.	
1844	20,601	£ 9,507	1843	27 03	1 1 0	
1845	30,038	£17,732	1845	21 62	0 17 6	

Value of coal imported from Europe into Brazil, and entered for consumption in the financial year 1842–3, paying an import duty of five per cent.

From Great Britian, 708,722 rials: France, 5,037: Portugal, 804: Hanseatic towns, 134,653: United States, 6,881. Total, 856,097 rials.

Lignite. In the neighbourhood of Crato, a town about three hundred miles due west from Pernambuco, within the limits of the cretaceous formation, a bed of lignite about two feet thick has been described by Mr. Gardner. An enormous area of rocks of the chalk period, according to this traveller, exists in this country. "Between the cretaceous series and the primary stratified rocks, there are no traces either of the carboniferous or of the oolite formations; nor in any part of Brazil through which I afterwards travelled, did I meet with any signs of them." In a note to the foregoing paragraph, the author observes, "Dr. Parigot appears to have found coal abundantly in the island of Santa Catherina, in the south part of Brazil."*

This latter gentleman was employed by the government to make geological surveys in the province of Santa Catherina, with especial reference to coal. In a report which he published in 1841, he mentions a bed of coal of about three feet in thickness, and of considerable superficial extent. Dr. Parigot, also, has reported upon the existence of a carboniferous stratum, which is from twenty to thirty miles in breadth, and about three hundred miles in length; running from south to north through the province. The best vein of coal which he opened he designated as "*half bituminous:*" it occurs between thick strata of the hydrous oxide of iron and bituminous schist.†

The coal which Spix and Martins informs us exists near Bahia, Dr. Parigot found to consist of beds of lignite, and Mr. Gardner thinks they may be equivalent to those which he found at Crato.

* Gardner's Travels in the Interior of Brazil, London, 1846, p. 208.
† Macgreggor's Progress of America, 1847; Vol. I., p. 1455.

BRITISH GUIANA.

Past-tertiary lignites.—An alluvial belt, thirty or forty miles wide, borders the coast and occupies the deltas of the principal rivers. In a thick mass of variously coloured clays beneath the diluvium, are two deposits of fallen trees, decayed wood, and other vegetable matter, in a semi-carbonized state. The first is at twelve feet below the surface, the second is fifty feet below the surface, and is twelve feet thick. This clay has been penetrated to the depth of one hundred and forty-five feet. The trees are recognized to be of the same species as are now growing in the vicinity, and called couridas, and indicate two or three distinct epochs and levels of surface on which they have grown.*

Coal has not, we believe, been discovered in this vast, but little explored country; yet it seems not altogether improbable that the coal formation may yet be found in the interior. Sir R. Schomburgh states that Maravacca, near the Orinoco, rises to eleven thousand feet; and Roraima, the culminating point of the Pacaraima mountains, is eight thousand feet above the sea. They are composed of the older red sandstone, and exhibit mural cliffs one thousand and sixteen hundred feet high.†

FALKLAND ISLANDS.

S. Lat. 51° to 51° 30′. Peat. These islands, destitute of coal or timber, are in some degree compensated by their extensive fields of peat, which vary in depth from two to four feet.‡ In the absence of all other descriptions of fuel, this species of combustible may, at some future period, be of great service to the inhabitants. In fact, even now, we are told that the want of wood is abundantly supplied by the peat, which is found in every part of this group of islands, and is collected with very little labour.§

The geological features of these islands have been described by Mr. Darwin.‖

* Byam Martin's Statistics of the Colonies of the British Empire, p. 120.
† Report of the British Association, for 1845.
‡ Hunt's Merchants' Magazine, February, 1842.
§ Martin's Statistics of the British Colonies, p. 144.
‖ Proceedings Geol. Soc. London, March 25, 1846.

WEST INDIA ISLANDS,

COMPRISING

1. CUBA.
2. JAMAICA.
3. PORTO RICO.
4. BARBADOES.
5. GUADALOUPE.
6. ANTIGUA.
7. TRINIDAD.
8. GRENADA.
9. ST. LUCIE.
10. MADEIRA.

THE WEST INDIES.

ISLAND OF CUBA.—[BELONGING TO SPAIN.]

Vicinity of Havana.—Bituminous substance called Chapapote, Asphaltum or Solid Bitumen.—Of this inflammable mineral substance there are many varieties, to which we shall refer in the progress of this book They differ in consistency, from a thin fluid to a solid compact mass, with conchoidal fracture, externally resembling coal, and in the West Indies, not unfrequently mistaken for that combustible.

German,	Judenpech,	*Spanish,*	Asfalto, Chapapote, ?
Dutch,	Jodenlym,		
Latin,	Asphaltum, Bitumen Judaicum,	*Portuguese,*	Asphalto,
		Russian,	Asfalt,
Italian,	Asfalto,	*French,*	Bitume.

These comprehend the several species named after their respective qualities, Naphtha; Petroleum; Maltha, or Sea wax; Elastic Bitumen, or Mineral Caoutchouc; Compact Bitumen, or Asphaltum; Mineral Pitch; Bitumen Candidum; Mineral Oil, the Seneca or Gennesee Oil of the United States.

The chapapote of Cuba, commonly called coal, is worked or mined much in the same manner as the latter mineral, and appears in several positions in the vicinity of Havana and Matanzas. We are enabled to speak of this substance from personal acquaintance with the localities. In the Transactions of the American Philosophical Society, Vol. VI. p. 191, and in the London and Edinburgh Philosophical Magazine of March, 1837, are notices of a vein of so called "bituminous coal," near Havana, by Richard C. Taylor. We refer to our original notes on which those communications were based.

Casualidad Mine.—Situated six miles from the city of Guanabacoa, three leagues from Havana, and two miles from the sea or place of embarkation. In a region of metamorphic and magnesian rocks, of which the most prevalent are serpentines, diorites, and euphotides, accompanied by veins of quartz, of chalcedony, and often of copper, occurs the substance denominated chapapote. Instead of a coal seam in the formation appropriate to that mineral, which we had been invited to inspect, we saw in the midst of these stratified rocks, true wedge-formed veins there, where they appear at the surface, but enlarging downwards to the breadth or thickness of several feet. The strike of the Casualidad vein is nearly north and south, conforming to the local range of stratification, although the general range is nearly east and west, following the direction of the island. At the point excavated by the negro workmen, the vein was laid bare, to the width and depth of near forty

feet, each way; its character being, for that space, fully developed, or sufficiently so to enable a plan and section to be constructed. At the outcrop the vein is scarcely a foot thick, but at the depth of thirty feet it is enlarged to nine feet, descending nearly vertically. Thus, at the rate at which it continued to increase, in the short depth proved, it was anticipated the mass beneath must acquire enormous magnitude. Several lateral branches pass upwards from the main vein, both in its vertical and longitudinal direction, all apparently ramifying from a voluminous mass below. Strictly speaking, the solid bitumen was in no case enclosed between walls, but seemed rather to occupy fissures in the ancient rocks, and cavities larger than we could venture to speculate upon. The outcrop was easily traced about two hundred to three hundred yards, but beyond this no effort had been made to prove the vein. Miserably inadequate as was the system adopted for the extraction of this coal, we could not but infer that an enormous amount of this substance might very cheaply be obtained. Under the management then going on, all the water, as well as the materials, was hoisted up by hand, in small vessels, and conveyed to a distance by a gang of negroes; economy in labour being in no respect consulted, and no kind of machinery, not even a windlass or wheelbarrow, was employed in the so called mine.

In regard to the arrangement of the matter of the vein itself, we noted, that the asphaltum was disposed in horizontal laminæ, whatever might be the inclination of the veins or branches; thus essentially differing from the usual character of coal seams, whose lamination is always parallel to the direction of the strata.

An analysis was made by Mr. T. G. Clemson; the result is as follows:

Carbon, -	34.97
Volatile matter,	63.00
Ashes or cinder,	2.03
	100.00

Specific gravity, in three different specimens, 1.142—1.169—1.197. Streak—dark, bistre brown.

Externally it is of a deep jet-black; having the horizontal surfaces of the laminæ covered with curious conchoidal markings, like the impress of a seal upon black wax. These impressions are marked with concentric, or rather with excentric rings, not unlike the lines of growth on the flat valves or upper shells of some bivalves. They vary greatly, in diameter, from only half an inch, to a foot.

A considerable quantity of this coal or asphalte we found excavated and stored; some of which had been employed by the smiths and workers of iron in Havana. From various causes, we understand that the mine has been prosecuted very feebly, and latterly has not been in operation; nor do the proprietors appear to have a ready market for the material.

Near Havana.—We see it announced that a combustible similar to that we have described, has been tried by the Spanish steam-frigates, and had been pronounced on very favourably. The analysis is as follows:

Carbon,	71.84
Oxygen and hydrogen,	14.66
Ashes and cinder,	13.50
	100.00

From the great amount of impurities in this specimen, we presume that it was derived from some other source than that of Casualidad mine.

Six leagues from the mine of Casualidad, towards Matanzas, a body of chapapote exists, from whence a few tons have been forwarded to Philadelphia, Liverpool, and London. The geology of the vicinity is of a corresponding character to that we have described.* The chapapote is, however, far more compact and solid than that of the Casualidad vein. It emits, when rubbed, an agreeable odour, resembling that of amber. It is very pure, free from all extraneous matter; its specific gravity is greater than that near Havana, and the mineral is more resinous and less friable.

There can be no doubt but this is an admirable combustible, where much flame is a desideratum, for such purposes as evaporation, and for heating surfaces; and in this respect it must be superior to many descriptions of fuel whose proportion of volatile matter is less. For the generation of steam, for boiling or concentrating the juice of the sugar cane, or for the manufacture of gas, this flaming coal appears to be singularly well adapted. In other respects it cannot, of course, compete with the intense, enduring, and concentrated heat of anthracite.

As it contains no sulphuret of iron, the gas would be wholly free from any deleterious admixture. The chapapote might also be profitably employed in the manufacturing of lamp-black. For domestic purposes it gives out far too much smoke, in burning, to form a desirable fuel.

Chapapote near Havana.—Other positions, in the neighbourhood of the principal mine of this substance, show its prevalence in the country. We have ourselves examined and reported upon some excavations, at two leagues from Havana; but they were not of so promising a character as at the Casualidad mine.†

Mine Prosperdad.—Partido de San Miguel.—Asphaltum.—Six miles from Havana, on the road to Taposte.

An article of M. Castáles, in the *Diaria de la Habana* of 1842, has appeared in the scientific journals of the United States, accompanied by the analysis last quoted, but which we derived from another source.

The substance here denominated bituminous coal, is of the two varieties to which we have alluded, and is developed to a surprising extent. Two shafts have been sunk here, forty-five yards apart. In the principal one of these, the coal or chapapote was reached at the depth of seven yards, and contained therein to the depth of forty yards—the bottom of the shaft. From the four sides of this shaft four straight exploratory galleries have been conducted, in opposite directions, thirty yards in length; in all which space the mass of bitumen continues horizontally, and without any interruption. At the bottom of the shaft, or of the forty yards above mentioned, instead of sinking further in the chapapote, the miners proceeded to bore perpendicularly down, about fifteen yards more;—always in coal. One of the galleries communicates with the other shaft, forty-five yards distant, still continuing entirely in coal. At four hundred yards from the principal shaft, a third pit has been sunk, which reaches the coal at the depth of fourteen yards.

The results of the explorations are these. In the small space indicated, a body of coal, asphaltum, or solid bitumen, is thus far proved to be forty-eight yards [one hundred and forty-four feet] perpedicular, and more than

* Silliman's American Journal of Science, 1842.

† Philosophical Magazine, R. C. T., March, 1837, and Transactions American Philosophical Society.

one hundred and eighty feet in surface or horizontal extent: that is to say, and it is to be understood, so far only as had been bored without reaching the bottom. The mass is spoken of as almost horizontal; but its true form cannot satisfactorily be ascertained from the foregoing data, and, moreover, the position of the stratified rocks is stated to be almost vertical.

According to the report of an English engineer, this is one of the most extraordinary mines in the world. By his account, which however is not particularly intelligible, the upper part was highly charged with bitumen, and was convertible into good coke. The lower portion consisted of an improved quality, being, as he thinks, less bituminous and much more compact. A railroad, we understand, has, of late, been constructed from the mine to the port.*

Punta Icacas.—The existence of solid bitumen in rocks, near the north coast of Cuba, not far from Matanzas, was known to the celebrated Von Humboldt. This mass, he observes, reminds us of the asphaltum of Valorbe, in the Jura Limestone.†

Something of the same kind also occurs at Puy de la Lège in France.

Asphaltum, in various degrees of density, occurs among the serpentine and magnesian rocks at other points on the Island of Cuba than those we have indicated. From the direct observations that we have been enabled to make, it seems very probable that all the bituminous matters, whether known under the names of Chapapote; Asphalte; Mineral Pitch; Petroleum; mastic bitumen; liquid or fixed bitumen, and other terms,—simple varieties of the same mineral substance, appear at the surface, at the points of fracture in the disturbed and metamorphic regions. In other words, "in the centres of dislocation of the beds."‡

Petroleum.—Springs are abundant near Havana, rising from fissures in the serpentine rocks at Guanabacoa, and have been known for two centuries at least. In fact, the whole country is impregnated with bituminous matter, to a surprising degree. Even the solid quartz, the serpentine rocks, and the veins of Chalcedony, have cells and cavities filled with liquid pitch; and the air is scented with it, when these rocks are broken by the blows of a hammer. In this respect it resembles the mineral pitch found filling the cavities of Chalcedony and calc-spar, in Russia.§

Even in the bay of Havana, the shore, at low water, abounds with asphalte and bituminious shales, in sufficient quantity for the paying of vessels, as a substitute for tar. It is stated that, in buccaneering times, signals used to be made, by firing masses of this chapapote, whose dense columns of smoke could be recognized at great distances, and served as signals to vessels at sea.

It is matter of history that Havana was originally named, by the early visitors and settlers, Carine;—"for there we careened our ships, and we pitched them with the natural tar which we found lying in abundance upon the shores of this beautiful bay."||

Petroleum leaks out in some, indeed in numberless, places, in this delightful island, from amidst the fissures of the serpentine, and perhaps has deeply seated sources. We are acquainted with abundant springs of petroleum between Holquin and Mayari, in the eastern part of the island, and also possess notices of others in the direction of Santiago de Cuba.¶

* Mining Review, October, 1840, p. 76. Also, Silliman's Journal of Science for 1842.
† Essai Politique sur l'Isle de Cuba.
‡ Office de Publicite.
§ Allan's Manual of Mineralogy, p. 291.
|| Early history of Cuba.
¶ Essai Politique sur l'Isle de Cuba.

In fact, the entire chain of the West India and Windward islands present similar phenomena of petroleum springs, beds or veins of asphaltum, and accumulations of mineral pitch, and traces of metamorphic and volcanic rocks, in great abundance.

M. Bousingault, in a dissertation on the bitumens of France, remarks that the only contradictory fact opposed to his conclusion that the geological position of mineral pitch is in formations referable to the supercretaceous group, is that given by M. de Humboldt, who saw at Punta d'Araya, on the coast of Carracas, petroleum issuing from mica slate. To these exceptions might be added many more; for we have seen in the greater part of the larger islands of the West India chain, that petroleum, mineral pitch, and asphaltum, in various degrees of solidity, appear between the fissures of ancient rocks, particularly of the magnesian class, serpentine, euphotide, &c., and in regions where no supercretaceous rocks occur, in their neighbourhood. So also, in Europe, bitumen occurs in older formations, from the coal measures down to granite.

The chemical results of these inquiries, however, are these:—That glutinous bitumens are mixtures of two substances, which we can isolate. One of these principles is solid and fixed, and in its nature approaches to asphalt. The other is liquid, oily and volatile, and resembles petroleum in some of its properties.*

Vegetable remains in Tufa.—The recent calcareous tufa deposits, so common in the north-eastern portions of Cuba, contain vast quantities of vegetable casts, impressions of stems and leaves, and seeds of plants, such as abound in the vicinity at the present time.† We have collected abundant specimens of these, at the base of the metamorphic limestone range of mountains on each side of Gibara.

SHIPMENTS OF COAL FROM GREAT BRITAIN TO THE WEST INDIES.

The trade in coals from Great Britain to the West Indies is limited. They are partly required for furnaces, but the principal quantity consists of a particular description of coal for steam purposes, under contract with the British government, and is a trade of comparatively recent origin.

The government stations are Jamaica, Antigua, and Barbadoes, and some coals go to St. Thomas's. The average price of the coals there is about 45*s.* to 47*s.* per ton, [=$10.90 to $11.40,] according to the demand. They have been freighted from London, costing 20*s.* per ton there. The freight from Newcastle to the West Indies is 27*s.* 6*d.* to 30*s.*‡

English bituminous coal imported into the British West Indies.§—In 1831, 48,536 tons; 1832, 43,980; 1840, 82,564; 1841, 71,311; 1844, 77,338; 1845, 102,339.

British coals imported into the Foreign West Indies.—In 1844, 26,592 tons; 1845, 22,154.

In the West Indies the price of coal varies from 45*s.* to 47*s.* per ton, for government contracts; it has been occasionally much higher.

The importations of copper ore from Santiago and other ports of Cuba, constitute a very considerable portion of the trade of Swansea. The ships employed in this trade are from 300 to 500 tons burden. The chief back

* Philosophical Magazine, 1837.
† Trans. Amer. Phil. Society, Vol. IX. p. 210.
‡ Evidence on the coal trade of London in 1838, p. 104.
§ Official Tables of Revenue, Commerce and Population.

freight for these ships is Welsh coal. It was feared by the shippers of this Welsh coal that the discovery of a supposed bituminous coal, of high value, at more than one point within a few miles of a shipping port of the island of Cuba itself, would materially diminish, if not entirely cut off, the market for the supply of the free-burning coals of South Wales.* Owing, however, to other circumstances, rather than to any deficiency in the quality of the Cuba asphaltum, there has not, at present, been experienced any change in the importation of foreign coals; but the demand in a tropical climate can never, we think, for obvious reasons, be very extensive.

II. JAMAICA.—[Great Britain.]

Three or four thin seams of *true coal*, embedded in shale, were described in 1825, by Sir Henry De la Beche, near the north-eastern extremity of the island.† None of these beds were in sufficient thickness to constitute a profitable or workable coal stratum. It appears, also, that bituminous coal exists on the other, or south side of the island, within ten miles of Kingston. It burns with a clear, bright flame, and is said to be good; but the thickness of the seam there is not mentioned.‡

Island Tariff.—On coals, [except those for the Royal Mail Company,] 6*d.* per ton; duties under the British act, 1842, 4 per cent.

III. PORTO RICO.—[Spain.]

In the returns of exports from this Spanish island, coals are mentioned. We possess no further information.

* Remonstrative to Sir Robert Peel, March, 1842.
† Trans. Geol. Society of London, Vol. II. second series, p. 143.
‡ Mining Journal, London, April, 1837.

IV. BARBADOES.—[GREAT BRITAIN.]

Compact bitumen or asphalte abounds here, as in several other West India Islands. In this, it supplies, in a great measure, the place of coal. Dr. Wilkins has published some "observations on the green mineral *naphtha* of Barbadoes."

The calcareous rocks here are frequently impregnated with bitumen. There is a *petroleum* or burning spring, at St. Andrew's parish. It goes by the name of green tar, and often supplies the want of pitch and lamp oil.*

Tariff on coals.†—Colonial duty on coal imported, 2*s.* per ton. Crown foreign duty, 20 per cent.

May, 1845.—It is announced that some "very superior coal" has been discovered on Grove Plantation estate, "and various parts of the island, which, for plantation purposes, is considered fully equal to the imported English coal." This substance may, perhaps, be the solid bitumen or asphalte above alluded to.

We have recently seen an analysis of this bituminous coal by Mr. Herapath, as follows. We place by its side in another column, the analysis of the Cuba chapapote, whereby the analogy of the two is satisfactorily shown:

	Barbadoes.	Cuba.
Bitumen, resolvable by heat into tar and gas,	61.60	63.00
Coke, or Carbon, - - - - - -	36.90	34.97
Ashes, (no sulphur,) - - - - -	1.50	2.03
Total,	100.00	100.00

Mr. H. observes, that "the large proportion of bitumen, in proportion to the carbon, will prevent this coal from being used as a common fuel, unless it be mixed with some substance more fixed in the fire. Hard charcoal, more refractory coal, and even perhaps earthy substances, would be beneficial. It could be employed in the production of gas, of which it would furnish a large quantity, and of a very rich quality, even exceeding that of cannel coal—the best for that purpose hitherto known."

The Chairman of the Barbadoes Railway has announced that the geological formation of the Scotland district of the island, which he had opportunities to inspect, leaves little doubt that it contains coal measures to a great extent.

The Barbadoes Standard confirms the above, and states that the result of a scientific examination of the parishes of St. Andrew and St. Joseph, leads to the confident belief of the existence of useful coal. This combustible, it is stated, is different from that bituminous substance so long in use in Barbadoes, of which the analysis by Mr. Herapath is furnished in a preceding paragraph.‡

* Dr. Skey in Geol. Trans. Vol. III. 1816.
† Mining Journal, 24th January, 1846.
‡ Mining Journal, 14th February, 1846.

GUADALOUPE.—[France.]

Contains a volcano, rising five thousand five hundred feet above the sea. It has no regular crater, but smoke issues out of three or four different spots. Not far from the shore, south-west of the volcano, is a place in the sea which sends up boiling hot water.

ANTIGUA.—[Great Britain.]

Although somewhat celebrated for the abundance of petrified tertiary wood that it contains, specimens of which, when polished, are exceedingly beautiful, it does not appear that coal has yet been discovered within the limits of the island.*

The monocotyledonous strûcture of the stems of palms is beautifully preserved in these lignites, and no examples surpass them in beauty and interest.†

Four distinct species of fossil palm occur in the pliocene tertiary of the island of Antigua.‡

TRINIDAD.—[New Granada.]

The *pitch lake*, lagoon, basin, or plain, [for it has been called by all these epithets,] is sufficiently remarkable to require notice in our list of deposits or accumulations of bituminous substances. It is described as three miles in circumference; but its depth is unknown, being incapable of admeasurement. This substance is used for paying the bottoms of ships, and probably differs little, except in density, from the chapapote of Cuba. We may not greatly err, if we ascribe them to a common origin.§

* Dr. Nugent.

† Mantell's Medals of Creation, Vol. I. p. 70.

‡ Professor Unger.

§ Allan's Manual of Mineralogy, art. Bitumen.

The pitch lake of Trinidad is, perhaps, the most remarkable locality of asphaltum in the world. It occupies the highest land in the island, and emits a strong smell, *sensible at ten miles distance.* Its first appearance is that of a lake of water; but when viewed more nearly, it seems to be a surface of glass. In hot weather, its surface liquefies to the depth of an inch, and it cannot then be walked upon. The geological data in the vicinity exhibit traces of volcanic agency: and not only in the lake itself, but in the neighbourhood, are seen holes and fissures, sometimes containing liquid bitumen.* Fissures of great length, from four to six feet wide, traverse the surface of this lake, in every direction, and are generally filled with water. The consistence and general appearance of the asphalte is that of pit-coal; only the colour is rather grayer. It is very brittle, and breaks into small cellular, glassy fragments. Some of the more elevated parts of the surface are covered with thin brittle scoria.

We know not if any practical employment of a mineral substance, here so astonishingly abundant, has yet been suggested or undertaken, on an extensive scale. It surely was not placed there in vain. Beside the purpose above mentioned, that of paying ships, and thereby protecting them from that pest of the West India seas, the *teredo*, or borer, it is capable of being used as an ordinary varnish, and in a variety of minor matters.†

It has been attempted to apply the asphaltum, brought from this lagoon, to the same objects as pitch and tar; but it is found to require so large an admixture of oil that it becomes too expensive. If it could be economically applied, Trinidad might furnish abundant supplies for the whole world.‡

Petroleum.—South of Cape de la Brea is a submarine volcano, which occasionally boils up, and discharges a quantity of petroleum. Another occurs on the east side of the island, which throws up on the shore masses of bitumen, black and brilliant as jet.

Coal.—Schistose plumbago has been discovered in Trinidad, and near it is a mine of coal, about five miles from the sea-shore.§ We have seen no details.

Lignite.—M. Link has made microscopical observations on some lignites from Trinidad, and has recognized therein the structure of the wood of the palm.‖

GRENADA.—[Great Britain.]

We have not heard of the discovery of coal beds, but it is reported by Dr. Simpson that the red secondary sandstone of this island contains vegetable fossils; such as the leaves and stalks of plants.¶

* Dr. Ure's Dictionary of Arts, &c.
† Essay on Bitumen; its uses in remote ages, and its revival in modern times, and applicability to various purposes, 1839.
‡ Trinidad Almanac for 1840. App. c. 4.
§ Martin's Statistics of the British Colonies, p. 25.
‖ Annales des Mines, Tome XVII. p. 575.
¶ Martin's Statistics of the British Colonies, p. 43.

ST. LUCIE.—[GREAT BRITAIN.]

In corroboration of the geological evidence, so frequently, and we may even say so universally presented, that the entire group or range of the Antilles, from Trinidad to Cuba, has been, from time to time, subjected to volcanic influence, which is occasionally felt even at the present day, we add here, that this island yet contains an active volcano. Its summit is more than four thousand feet above the sea level, and within its crater are several deep depressions, filled with boiling water and mud. From one of these rises, at intervals, a column of smoke. The last eruption of this volcano, of which we have any information, took place in 1812.*

ISLAND OF MADEIRA.—[PORTUGAL.]

Brown coal or lignite occurs on the north side of the island, on the banks of one of the tributaries of the St. George. Professor Johnstone considers it to be the dried relict of an ancient peat bog, and that its lustre, compactness, and rhomboidal fracture, are due to the action of the basalt which overlies it. An analysis gave

Carbon, - - - - - -	60.70
Hydrogen, - - - - - -	5.82
Oxygen and nitrogen, - - -	33.48
	100.00

and 20.05 of ash. This is the organic constitution of true peat; but no peat exists at present in Madeira, nor has been noticed so near the equator. It is suggested, therefore, that this deposit may indicate a former colder climate in that latitude.

* Geography of America and the West Indies, p. 26.

EUROPE,

COMPRISING

1. GREAT BRITAIN—I. England. II. Scotland. III. North Wales. IV. South Wales. V. Ireland.
2. FRANCE.
3. BELGIUM.
4. ZOLLVEREIN AND PRUSSIA—Twenty-two States.
5. SPAIN.
6. PORTUGAL.
7. I. NORTHERN ITALY. II. SOUTHERN ITALY—Sicily, Calabria, Naples, Tuscany, the Papal States.
8. IONIAN ISLANDS—ZANTE.
9. GREECE—Bœotia, Samos, Grecian Archipelago.
10. EUROPEAN TURKEY—Ottoman Empire.
11. SWITZERLAND.
12. AUSTRIAN EMPIRE—Sardinia, Savoy, Piedmont, Tyrol, Austria, Transylvania, Moravia, Silesia, Croatia, Dalmatia, Carinthia, Carniola, Istria, Illyria, Styria, Galicia, Hungary, Bohemia.
13. HANOVER.
14. HANSE TOWNS.
15. POLAND.
16. HOLLAND.
17. NORWAY.
18. SWEDEN.
19. DENMARK—Bornhohm, Feroë Islands, Suderoë Island.
20. RUSSIAN EMPIRE—Southern, Northern, Central, Eastern.
21. POLAR SEAS—Cherie Island, Spitzbergen, Iceland.

GREAT BRITAIN.

Entire *area* of England, Wales, Scotland, the Scottish Islands, Ireland and the Channel Islands. Square miles, 120,290; acres, 76,985,382.

Population,

In England 1831, 13,091,005; Wales, 806,182; Scotland, 2,365,114; Ireland, 7,767,401; British Isles, 103,710; Army and Navy &c. 277,017. Total, 24,410,429. In England and Wales, in 1845, 16,684,600; in 1846, 17,000,000, and over. Total amount, 27,020,000.

The whole area of the British Empire is now computed to be, 6,890,000 square miles, or 4,712,760,000 acres.

Estimate of the annual value of the mineral produce of Great Britain, by Mr. Tennant, in 1846:—

Coals, £9,100,000; Iron, £8,400,000; Copper, £1,200,000; Lead, £920,000; other metals and salt, £5,380,000. Total annual value of productions, £25,000,000.

Money, Weights, Measures.

Gold.—The standard gold sovereign containing 1-12th alloy, weighs 123.274 grains.

1 lb. troy of this standard gold, computed at £3. 17. 10½ per oz., is coined into 46.74 sovereigns = £46. 14. 6. No duty is charged on its coinage.

Value of the sovereigns in the United States currency = \$4. 83c. 8m.

Silver.—The standard silver contains 18-240ths alloy.

1 lb. of this silver is coined into 66 shillings, of which 4 are taken as seignorage, or mint duty; nearly 6 per cent. Value per lb. standard £3. 6. 0. Each shilling contains 87.27 grains standard.

1 lb. troy of the same silver is coined into 32 Company's Rupees, of which 2 per cent. are taken as mint duty.

Copper is valued at £224 per ton = 24 pence to the pound avoirdupois.

Comparitive Currencies.

	English. *s. d.*	French. *franc ct.*	United States. *dollar c.*
Spanish Piastre,	4 4½	5 43	1.05
Prussian Rix dollar,	3 0		0.72
United States dollar, 4*s.* 16*dec.*,	4 1½	5 18	1.00
Hindostan, Sicca Rupee,	2 0		0.48
French, Franc,	0 9 69	1 00	0.19.3
English, Shilling,	1	1 16	0.24

Weights.

1 lb. avoirdupois, = 453.544 Grammes of France = 0.97 lb. of Berlin.

112 lbs. = 1 cwt. of which 20 cwt. makes 1 ton = 2240 lbs. English = 1 quintal Engl.

1 English ton = 10.1465 metrical quintals, or 1,015 Kilogrammes of France.

1 Kilogramme usuel of France is 2*lb.* 3*oz.* 4½*dwt.* avoirdupois.

1 metrical quintal of France is 220 *lbs.* English = 100 Kilogrammes.

Weight of 1 Newcastle chaldron of coals, 2,675 Fr. Kilog = 2 tons and 13 cwt. Engl.

Weight of 1 Last about 3⅓ tons, = 99.54 cubic feet.

26½ cwt. was the legal weight, by act of Parlt. 1831, of 1 London chaldron of coals.

53 cwt. 1 Newcastle chaldron.

1 barrel of meat = 200 lbs, 1 tierce of do. = 304 lbs.

1 sack of flour = 280 lbs.

Measures of Capacity and Solidity.

1 English Winchester bushel contains 2150.42 inches = 35.236 French Litres.

1 English Imperial bushel contains 2218 inches weighing 80 lbs. of water.

2.84 English Winchester bushels = 3½ cubic feet = 22 imperial gallons = 1 hectolitre.

26⅔ English bushels to 1 ton, when dry.

1 English bushel weighs 84 or 85 lbs.

1 ton = 252 imperial gallons.

On the old system of selling coals by measure.

1 sack of coals - -	= 3 bushels.
1 vat - - -	= 3 sacks.
1 heaped London chaldron -	11 sacks. 36 bushels. 4 vats.
21 chaldrons - - -	= 1 score.
1 Imperial bushel even, -	2218 cubic inches.
1 Imperial bushel heaped, -	2815 do.
1 Boll = 36 Winchester gallons,	= 9675 do.
1 Fother, - - -	= 77,414 do.
1 Last, [now used in the Hanse Towns.]	= 99,540 cubic feet.
7½ bolls, - - -	= 1 cubic yard of coal.
6 bolls, - - -	= 1 chaldron.

In Ireland, 1 barrel or kish represents 6½ cwt. or about 3 barrels to 1 ton.

In Scotland, 36 cubic yards of coal are equivalent to 32 tons weight.

In England, 1 cord of wood is 4 feet high, 8 ft. long and 4 ft. deep = 128 cubic feet.

Measures of Length and Area.

1 French mètre is = 3*ft.* 3*in.* 37*dec.* = 3*ft.* 28*dec.* = 39*in.* 371*dec.*

1 English imperial acre = 4840 sq. yards,	0.4046 Hectars of France. 1.561 Morgen of Prussia. 0.7025 Joch of Austria.

The imperial acre, English, is to the Scotch acre as 1 to 1.261.
do. do. Irish acre as 1 to 1.62.
1 Irish acre contains 1 acre 2 roods, 19 poles English.
30¼ Irish acres are equal to 49 imperial acres.

The English commercial and financial year closes on the 5th of January, annually.

THE COAL-FIELDS OF GREAT BRITAIN—THEIR INFLUENCE ON HER PROSPERITY.

In the following pages, although expressly appropriated to British coal statistics, the English reader will probably discern little of novelty or originality. Our office, according to the plan of the present work, is, in a great measure, the arrangement and concentration of details which, in various shapes and through various channels, have been, from time to time, made public. On entering upon so important a section, we might commence by expatiating, with others, on the incalculable value to Great Britain of her deposits of mineral combustibles and ores; on their surprising influence on her power at home and abroad, and on the share they have had in raising her to her present lofty position among the nations of the earth. The data thus brought together, and the conclusions to which we are conducted, naturally suggest the tracing of the progress towards such a magnificent result. At the same time, it must be admitted, from the evidence which these pages contain, that this island, so fortunately circumstanced, is not destined to remain a solitary instance of rapid advancement in productive and industrial prosperity, through the agency of coal and iron. Other, and distant countries, following so successful an example, are applying themselves with energy to the development of similar resources. However rapid the progress made by England, we are able to show that France, Belgium, Prussia, and the United States of America, are, in our day, scarcely less active in relation to mining and manufacturing industry. The extraordinary advantages which have elevated Great Britain to her present eminence are, in great measure, of local origin. They are mainly ascribable to that bounteous supply of mineral wealth which nature has assigned to her; to the enterprising character of her people who have turned them to such good account, and to her insular position.

To her peculiar geology, also; to the disposition or distribution, within her rock formations, of the mineral substances that are pre-eminently the most serviceable to mankind; to their extraordinary accessibility, and to the abundant facilities for transportation, from within and from without, this country is especially indebted. "From the Grampians to Sussex, and from the German Ocean to the Irish Sea, the predominating geological feature of the British island is the carboniferous series, with the most magnificent coal deposits, accessible in every direction. These have been the source of Britain's internal riches, and the great cause of the development of the mechanic arts, which distinguish her above all other countries. Had the granite of the Grampians, it has been said, and said justly, extended into Sussex, or the chalk of Sussex to the Grampians, the whole course of British history would have been changed. Nineteen of our most important manufacturing cities, which lie upon the new red sandstone; drawing, from beneath

it, the coal, iron, and lime—the sources of their manufacturing prosperity,—in either case, it is probable, would never have existed."*

It is due to the unrivalled accessibility, by sea, to the best coal basins of England, Scotland and Wales, from so many points around the circumference of the island,—where coals of many varieties and admirable qualities, can be shipped at the very sites where they are mined,—that Great Britain has hitherto been able to furnish such enormous and cheap supplies, not only to the home consumers, but nearly to every maritime country in Europe. In this respect, she is far more favourably circumstanced than her rival continental producers, France, Belgium, Prussia, and Austria, whose coal-fields lie remote from the seaboard.

From Dunkirk to Bayonne, an extent of three hundred leagues of coast, there are but two coal-fields, and those are at some distance from the sea. In regard, also, to the quality of the coal, France is less fortunate than England; for, with the exception of the basins of Anzin, Saint Etienne, and a few others, the collieries of the interior yield an inferior species of carbonaceous fuel.† Both these circumstances combine to render France, to a certain extent, dependent upon Great Britain for the better sorts of coal. Hence, the French government annually make large and increasing contracts for the delivery of English coals, at their various depots, for the use of their steam marine, on service.

The incapability of Belgium—with her own increasing domestic consumption, and in view of her diminished powers of production, and the remoteness of her coal-fields from the sea-ports,—to supply the steam navy of France with any material portion of its requisite fuel, is perfectly well understood. The diminished supply to France from Belgium, in 1846 and 1847, and the corresponding increase from Great Britain, will be seen from our statistical tables. As to Spain, when the immense newly opened coal-field of Asturias, lying adjacent to the Bay of Biscay, shall be adequately developed, and its qualities more fully ascertained, it will be seen how far she can, independent of her own increasing demands, meet the growing wants of France and of Southern Europe. In the mean while, should it continue the policy of England to diminish her own indigenous resources, by furnishing so largely and so freely to the other European nations, there seems, at present, no reason to doubt her ability to do so, for a long time to come, even at an accelerated ratio.

During the discussion of the railway system in England, an interesting fact was pointed out by a writer from whom we have already quoted, that the various coal-fields of England and Scotland, will, from each adjoining field, meet the next adjacent coal-field nearly on a radius of thirty miles; thus forming a chain of deposits from Scotland to South Wales. The whole interior country, therefore, from north to south, it is estimated, will be supplied with coals through the agency of the railroad system, nearly within that circumference, from their several central points.

The east and west coasts, to their very verge, do not exceed fifty miles at any point, from the nearest coal district. The south-east and south-west of England; the north of Scotland, and the north-west of Ireland, form the most distant points; yet those do not exceed 150 miles. The object of the author, from whom we quote, is hence to show, that if London, not more than 100 miles from the nearest mines, can be supplied with railway-carried

* Pamphlet under the title of "Ships and Railroads," in 1846. Also, Mining Journal, May 30th, 1846.

† Mining Journal, Sept. 30th, 1846.

coals, it is evident that the interior of the country, at no point fifty miles, and in general, less than thirty miles, from the coal mines, with immaterial exceptions, will be more certainly and extensively supplied by similar means than through the sea-ports, and that a consequent diminution of the coasting trade must ensue.* It is therefore inferred, and we think with good reason, that the English railroads seem destined, at no distant time, to diminish the shipments by sea, for home consumption, except from the coal districts on the seaboard, and also for long distances; as they have already almost superseded canals in the interior.

ANNUAL PRODUCTION OF COAL IN GREAT BRITAIN.

As there is no system of supervision adopted in the mining regions here, as in all the other countries of Europe, it is impossible to arrive at any exact account of the quantity of coal which is annually raised in the mines; and, although the shipments from the sea-ports are registered with regularity, no returns are made, or are obtainable, of the consumption in the interior. Consequently, we have but an imperfect knowledge of the actual annual yield of the mines, and all the published statements are but crude approximations. Sir H. T. De la Beche, in a chapter on Economic Geology, showed by tabular documents, in 1840, that the average *value* of the annual produce of the British islands, amounts to the sum of twenty millions sterling; of which about eight millions arise from iron, and nine millions from coal, at the pit's mouth.

A more recent estimate, by Mr. Tennant, probably derived from the same source, places the annual value of the iron produced, at £8,400,000, and of the coal at £9,100,000.

Annual amount produced.—In 1839, Mr. McCulloch published the following estimate of the total produce in Great Britain, which statement was generally considered, at the time, to be more accurate than any other, but still under the mark.

	Tons.
Domestic consumption and small manufactures, -	18,000,000
Employed in iron making, and general manufactures, railways, steamboats, &c. - - - - - - -	10,575,000
Exports to Ireland, - - - - - - -	1,000,000
Exports to colonies and foreign parts, - - -	1,449,417
In 1839,	31,024,417

A later estimate brings up the aggregate production to 34,000,000, and we have even heard of estimates as high as 36,000,000, and the consumption in the interior is calculated at 23,500,000 tons.

The latter calculations are, from the reasons given, somewhat doubtful. Assuming them to be approximately correct, the production of the year 1845 may be thus stated.

	Tons.
Shipped coastwise, as per official returns, - - -	8,723,468
Shipped to the colonies and foreign countries, - -	2,531,282
Interior consumption, of which 12,000,000 tons were estimated to be consumed in the iron works, -	23,500,000
In 1845,	34,754,750

* "Ships and Railways," 1846.

That the quantity assigned for the consumption of the interior, in 1845, is not overrated, we may form some idea from the fact stated, in 1816, by a committee of the coal-owners of Durham and Northumberland, that 10,808,046 tons of coal were annually transported by the land carriage and canals of the interior, while the whole amount shipped, both for foreign and domestic consumption, was only 4,000,000 tons. At the same time, it was understood that the demand for coal for the iron and other manufactories of South Wales, was not less than 5,000,000 tons.

The increased demand for domestic use, for iron works, potteries, glass-works, factories, steam engines, &c. in the interior, and the improved facilities for transportation, during the interval of thirty years, has immensely enlarged the internal "movement" of coal.

In 1844, it was ascertained that the number of persons employed in the mining of coal and iron ore in Great Britain, Belgium, and France, were respectively as follows.

		In G. Britain.	In France.	In Belgium.
In Prussia, 25,000				
In Pennsylvania, 15,000	In coal mines,	118,233	29,320 persons.	38,490
	In iron mines,	10,949	1,963 "	2,808

GENERAL SHIPMENTS FROM THE PLACES OF PRODUCTION.

The following table shows the aggregate quantities of all coals, coke and culm, shipped, both for *foreign exportation* and for *home consumption*, coastwise, from British ports, in the following years.

Years.	Tons.	Years.	Tons.	Years.	Tons.
1819	4,365,040	1828	5,603,807	1841	9,498,193
1820	4,803,427	1836	7,389,272	1842	9,648,973
1822	4,788,839	1837	8,204,201	1843	9,313,295
1824	5,279,192	1838	8,504,142	1844	9,076,343
1826	5,856,547	1839	8,672,430	1845	11,254,750

COASTWISE SHIPMENTS AND COLONIAL TRADE.

Statement of the quantity of Coal shipped at the several ports of England, Scotland, and Ireland, coastwise, to other parts of the United Kingdom.

Coastwise Shipments.					
Years.	Tons.	Years.	Tons.	Years.	Tons.
1836	6,472,404	1841	7,649,899	1844	7,377,862
1837	7,090,691	1842	7,651,523	1845	8,723,468
1839	7,223,913	1843	7,447,084		

Table of the quantity of Coal shipped from British ports to the Colonies and Channel Islands.

Shipments to the Colonies.				To the Channel Islands.
Years.	Tons.	Years.	Tons.	Tons.
1819	71,497	1841	344,729	
1822	111,822	1842	333,000	
1825	114,264	1843	307,000	
1828	128,092	1844	278,943	65,900
1834	177,721	1845	375,302	55,588

Statement of the quantity of coals and culm brought coastwise, [and by inland communications,] into the port of London, in tons weight: from various parliamentary returns: including also the number of vessels or cargoes, the prices paid in the north, and amount of duties received thereon in London.

Note.—Occasionally discrepancies are observable between the returns adopted here, and found in other sources, considered to be official. In some of the latter cases they include the coal brought by sea only, omitting the small amount of inland coals. In others, they represent the quantities entered annually for payment of duties: while other tables, derived from the chamberlain's office, show the quantities imported, as computed from the arrivals, in the same periods. 10*d.* per chaldron, for weighing and measuring coal.

	Years.	Entered for duty. Tons.	Ships coastwise or cargoes.	Prices at Newcastle and Sunderland.			Coal duties received in London.
				s.	*d.*	Dollars.	£ Sterl.
Duty 13*s.* 9¾*d.* per chaldron,	1699	300,000					
Duty 12*s.* per new chaldron,	1781	821,627					26,927
Subject to coast duty of 9*s.*	1801	1,077,610		10	4	2.50	38,391
4*d.* per London chaldron,	1820	1,692,335		13	0	3.15	52,410
reduced to 6*s.* in 1824.	1822	1,667,307		11	11	2.89	54,850
Coals brought by sea only.	1825	1,856,606	6,564	12	8	3.05	63,649
Subject to public import duty	1826	2,040,291	6,810	13	6	3.27	63,277
in the Thames, 4*s.* per ton	1827	1,882,321	6,491	13	6	3.27	60,147
or 6*s.* per London chal-	1828	1,960,559	6,750	13	6	3.27	62,582
dron, of 25½ cwt. and mu-	1829	2,018,975	6,992	12	9	3.07	65,076
nicipal duty of 4*d.* per ton,	1830	2,079,275	7,108	12	4	2.97	64,628
	1831	2,053,673	7,006	12	4	2.97	62,836
	1832	2,149,820	7,528	12	3	2.95	72,196
After the repeal of the Lon-	1833	2,014,804	7,077	10	6	2.55	39,898
don duties, March 1, 1831.	1834	2,080,547	7,404	10	9	2.61	69,010
Brought both by sea and by	1835	2,299,816	7,958	11	0	2.67	68,005
inland navigation, - -	1836	2,403,673	8,162	11	0	2.67	76,765
	1837	2,546,066	8,720	11	0	2.67	79,915
	1838	2,581,085	9,003	11	0	2.67	85,197
	1839	2,638,316	9,340	11	0	2.67	
	1840	2,589,087	9,132	11	0	2.67	
Coastwise and inland, -	1841	2,942,738	10,272	11	0	2.67	
	1842	2,754,719	9,691				
	1843	2,628,520	9,593				
Duty 4*s.* per ton, - -	1844	2,536,166	9,466				Free.
Duty removed, - - -	1845	3,403,320	11,987				
	1846	2,953,755	10,488				

The increase, from 1800 to 1846, is ascribable, mainly, to the enlarged employment of steam power, and steam navigation, in addition to the enormous consumption for gas-lighting.

From 1841 to 1844 there appears to be a gradual diminution in the supply: but in 1845 it was compensated by the largest importation that ever entered the port of London: being an increase over the preceding year of 2521 ships, and 912,410 tons. To this may be added the quantity which passed through the city boundary, and that brought by railway, amounting to 68,687 tons: Total, 3,472,007 tons, in 1845.

Statement of coals conveyed to London by Inland or Canal Navigation, included in the general table.

Years.	Tons.	Years.	Tons.
1832,	10,742	1837,	2,324
1833,	4,395	1841,	33,594
1834,	1,862	1842,	31,519
1835,	1,004	1844,	72,256
1836,	1,199	1845,	68,687

By report P. IV. of the Committee on the Coal Trade of London, in 1838, a duty of 13*d.* per ton has been imposed on all coal entering the port of London, brought by railways within a radius of sixteen miles of the city of London; and a clause has been introduced into every railway bill since, which could be effected by it, imposing that charge of 13*d.* per ton.

Previous to the repeal of the duties on coal imported into London, 1st of March, 1831, they were heavy and oppressive, being seven or eight in all, both for the public and municipal charges. The whole amount of city dues now payable is 1*s.* 1*d.* per ton, referred to in the last paragraph.

We had prepared a chronological statement, at some length, of the original duties from 1695 to 1831, their various modifications, objects, &c; but as there is no utility in preserving such a record, we have omitted it.

Classification of Coals imported into the Port of London, and sold at the Coal Market, in tons weight.

Description of Coals.	1834.	1836.	1839.	1842.	1843.	1845.
	Tons.	Tons.	Tons.	Tons.	Tons.	
English, chiefly from the Newcastle region,	2,007,860	2,341,718	2,563,224	2,660,253	2,534,687	
Scotch coal,	39,487	22,664	29,276	19,484	12,108	
Welsh coal and culm,	33,200	33,970	45,816	74,982	81,725	
	2,080,547	2,398,352	2,638,316	2,754,719	2,628,520	3,461,199

By this table it will be seen that the amount of Welsh coal and culm brought to London has increased in nine years 145 per cent.; the Scotch coal has, on the contrary, diminished in amount about 100 per cent., while the English coal has increased 26 per cent. in the same period of time.

In proof of the singular increase in the coal trade of London, it has been stated that formerly, viz. towards the commencement of the business, two ships were sufficient to supply the city with coals.

In 1615, 400 sail were employed in the coal trade; one half of which number supplied the demands of London.

In 1703, 600 ships were engaged in the London coal trade.*

In 1841, 6873 collier brigs were employed in the home and foreign coal trade of the northern coal-field only.

In 1840, the tonnage of the colliers in the river Thames amounted to 2,628,323 tons.

In 1825, there were 6,564 ships' cargoes entered for duty at the port of London.

In 1846, 10,488 ships cargoes, and the previous year, 11,987.

The largest quantity of coal sold in the London coal market, in one day, took place on the 21st October, 1844. There were 282 cargoes, amounting to upwards of 80,000 tons; in all, 340 cargoes were at market, only 58 of which remained unsold.

We annex the following statement of the periodical cost of coal from 1395 to 1846, in the ports of the Northumberland coal-field, and the value of the same coal in the Thames.

Table of the average Wholesale Prices of the best Newcastle Coals at the Ports of Production and Consumption, including the Duties and Dues, in English and American Currency.

Years.	In the north on board ship at per Newcastle chaldron of 53 cwt.	In London at per London chaldron of 26½ cwt.	Years.	In the north on board ship at per Newcastle chaldron of 53 cwt.	In London at per London chaldron of 26½ cwt.	Value in United States currency per chaldron.
	s. d.	s. d.		s. d.	s. d.	
1395	3 4	0 0	1800	26 0	53 0	$12 82
1536	2 6	8 0	1810	34 0	53 0	12 82
1560	0 0	16 0	1820	33 0	37 0	8 96
1626	7 6	00 0	1825	32 0	39 0	9 44
1635	10 0	00 0	1830	25 6	33 0	7 98
1656	11 0	17 0		Tons.	Tons.	Tons.
1673	00 0	22 0	1835	10 9	21 9	$5 08
1701	10 6	18 3	1840	11 0	22 0	5 32
1789	19 0	32 9	1844	10 0	20 0	4 84
1794	00 0	44 1	1846	7 9		
			1847		17 6	4 24

A great amount of information, in relation to the progress of the coal-mining in the north, the prices in the London markets, charges, duties, &c., are to be found in Mr. Dunn's work on the coal trade, 1842. Also in McCulloch's Dictionary, and in the report of the committee on the coal trade of the port of London. See also in this work, under the head of the Newcastle coal-field.

It must be admitted, in relation to the prices of coal in the Thames, even with the official returns before us, it is impossible to arrive at the exact average account, unless we were to furnish the voluminous detailed list, so numerous are the varieties of quality and of consequent gradations of price. By the table, No 8, in the report of 1838, referred to, the various descriptions of coal brought into the port of London, are shown to be no less than 176 qualities, as follows:

* Report in 1838, Appendix, p. 240.

North of England coals, 163 qualities; Small coals, various, 9; Scotch, 1; Welsh, 1; Yorkshire, 2; Total, 176.*

In the tables No. 9 and 10 of the same report, it is shown that there were in the London coal market, on the 15th of May, and the 15th of Sept. 1837, 86 qualities of coal on the same day. The rivers Tyne and Weare collieries alone supplied 112 varieties of coal, in 1838, the average prices of which, on ship-board, were from 7*s.* to 11*s.* 6*d.*—or from $1.69 to $2.78 United States.

Small coals are not brought into the port of London, except for gas-making. The quantity of ballast required by the collier ships in the Thames, after discharging, is ten thousand tons per week. This ballast, or gravel, is raised out of the river Thames by the steam dredgers, which keep 52 barges in constant employ.

Coal employed in London for Gas-lighting.—It was in 1803 that Mr. Winsor first exhibited the effect of gas-light, at the Lyceum Theatre, London. Since then, it has been adopted for almost every purpose of illumination, and has afforded a market for the small and soft coals. Of the quantity of coal delivered in London, it was estimated by Mr. Brand, in 1834, that 255,000 tons were consumed, in the metropolis and suburbs, in furnishing gas-light. This amount, he calculated, was equivalent to 71,430 tons of mould candles, at six to the pound.†

In a memorandum, published in 1840, on the "statistics of gas," the quantity of coal consumed by the eighteen public gas-work companies in London and the suburbs, is put down at a smaller estimate than Mr. Brand's, namely, at 180,000 tons; reduced, probably, in consequence of the introduction of other substances, in lieu of coal, at some of the establishments. The whole works furnish 1,460,000,000 cubic feet of gas per annum, and employ 25,000 persons in the preparation, and 380 lamp-lighters.‡ More recently, 1845, a statement has been made, that there were nineteen gas companies, who produce, on an average, 10,000,000 cubic feet of gas every twenty-four hours; which is at the rate of 3,650,000,000 cubic feet a year. The whole number of lights is calculated at 100,000.§

In 1838, it appeared in evidence before a parliamentary committee, that the London gas companies annually consumed 340,000 tons of coals—amounting to one-eighth of the whole consumption of London.||

Periodical prices of coal in the Port of London.—The prices in the London market vary greatly, according to quality, and range from 13*s.* to 23*s.* per ton; and the average for the better description is probably 18*s.* to 20*s.*, or from $4.50 to $4.84 per ton, wholesale.

A statement which was published on good authority, in 1842, gave the following as the average wholesale prices per ton of all coals, in the Thames, after deduction of all duties and dues, and also those of the northern ports:

	Prices in the Port of London.				At Newcastle and Sunderland.	
Years.	Steam Coal.		Gas Coals.		Best Household Coals.	
	£. s. d.	Dollars.	£. s. d.	Dollars.	£. s. d.	Dollars.
1830	0 19 6	4.74	0 19 4	4.70	0 12 4	2.99
1840	0 17 6	4.26	0 16 2	3.83	0 11 0	2.67
1841	0 16 9	4.07	0 15 0	3.65	0 11 0	2.67

* The varieties of Welsh coal are very numerous.
† History of Fossil Fuel, p. 422.
‡ Mining Journal, 1840.
§ McCulloch; also the statement of Mr. Ward, 1845.
|| Minutes of evidence, 1838, p. 196.

Prices of Coals.—The highest price charged in 1842, at the shipping ports, for coal exported for gas-lighting, was 6*s.* 6*d.*, = $1.56 per ton; and the highest price charged for coal suited to steam purposes, was 8*s.*, = $1.92 per ton. The London Gas-light Company contracted, in that year, with parties to deliver Peareth Walls-end coal to the extent of 35,000 to 40,000 tons per annum, at the rate of 6*s.* 10½*d.*, = $1.60 per ton. A northern coal proprietor stated, at the same time, that "the actual cost of our best coal is 5*s.*, = $1.20 per ton, which we sell for 6*s.*, = $1.44 per ton, leaving a profit of 1*s.*, = $0.24 per ton. The actual cost of our inferior coal is 1*s.* 3*d.*, = $0.30 per ton, which we sell for 3*s.* 3*d.*, = $0.78, leaving a profit of $0.48 per ton."*

By official returns of that date, it appeared that the average cost of all the coals exported from Great Britain was 7*s.*, = $1.45 per ton. The tariff, therefore, imposed in 1842, amounted to an average of 45 per cent. in foreign ships, and near 33 per cent. in English vessels.†

The following table has been prepared to show the average prices of the best coal, as well as anthracite, per ton, in the river Thames, in the following years.

Years.	Best bituminous coals. £ s. d.	Dollars.	General range.	Anthracite and steam coal. £ s. d.	Dollars.
1838	1 3 0	5.56	18*s.* to 25*s.* 6*d.*	1 7 0	6.53
1840	1 1 0	5.08	17*s.* to 23*s.*	1 6 0	6.29
1842	19 0	4.60	16*s.* to 21*s.*	1 0 0	4.84
1843	18 0	4.36	15*s.* to 20*s.*	1 0 0	4.84
1844	1 2 0	5.32	17*s.* to 23*s.* 9*d.*	0 19 0	4.60
1845	15 0	3.63	14*s.* to 20*s.*	1 1 0	5.08
1846	17 0	4.12	13*s.* to 20*s.*	1 1 6	5.56

We have condensed, from several tables, an account of the periodical contract prices of the best Newcastle coals, per chaldron of 25½ cwt., and per ton of 2240 lbs., which were supplied to public institutions,‡ in English and American currency.

Greenwich Hospital.							Bethlem Hospital.			Chelsea Hospital.	
Years	Chald. £ s. d	Ton in £ s. d.	Ton in Dolls.	Years.	Chald. £ s. d.	T on in Dolls.	Years.	Chald. £ s. d	Ton Dolls.	Ton £ s. d.	Ton. Doll.
1730	1 4 6	0 19 7	4.72	1830	1 12 11	6.38	1815	2 10 10	9.80		
1740	1 9 0	1 3 2	5.56	1832	1 4 3	4.66	1820	2 5 9	8.82		
1750	1 7 7¼	1 2 1	5.30				1825	2 2 9	8.20		
1760	1 12 8	1 6 2	6.52		Ton.		1830	1 13 10	6.60		
1770	1 9 1¼	1 3 3	5.58				1831	1 7 3	5.26		
1780	1 17 3¾	1 9 10	7.16	1834	0 14 11	3.61	1832			1 3 0	5.57
1790	1 14 4½	1 7 6	6.60	1835	0 16 9	3.93	London Hospital. Ton.				
1800	2 11 7	2 1 3	9.90	1836	0 17 3	4.19					
1810	3 0 8	2 8 6	11.64	1837	1 1 3	5.14					
1820	2 5 9	1 16 7	8.80	1838	1 1 11	5.30	1834	0 18 6	4.48		
							·1836			1 2 0	5.33
							1837	1 4 6	5.92	1 2 6	5.45

* Mining Journal, March, 1842.

† "Observations on the proposed duties," 1842, p. 7.

‡ Parliamentary Tables of the Revenue, Commerce, and Population of the United Kingdom; and the Report on the Coal Trade of the Port of London.

British import duties on Coals.

	Years.	£ s. d.	Dollars.	
	1787	0 16 10	7.47	per chaldron.
	1819	0 2 8	0.64	do
	1834	2 0	0.48	ton
1835	to 1842	Free.		
1842	to 1845	0 1 0	0.24	do in foreign vessels.
		0 0 6	0.12	do in colonial vessels.
1845	to 1847	Free.		

Table of British export duties on Coals: called by the trade "The over-sea duty."

Years.	Details.	Per Newcastle chald. of 53 cwt. £ s d	Per Newcastle chald. of 53 cwt. Dolls.	Per ton of 20 cwt. £. s. d.	Per ton of 20 cwt. Dolls.
1630	. . . . .	0 5 0	1.25	0 1 10	0.44
1695	. . . . .	0 5 0	1.25	0 1 10	0.44
1790	. . . . .	0 15 5	3.73	0 5 10	1.41
1800	. . . . .	1 2 3	5.38	0 8 4	2.00
1810	. . . . .	1 5 0	6.05	0 5 8	1.36
1819	In British vessels,			0 2 0	0.48
to 1831, 23d Aug.	Large and small coal, Forign shipping,			0 10 0	2.42
	Large and small coal, British vessels,			Free.	Free.
From 23d Aug. 1831	Large coal, British "			0 3 4	0.80
	Large coal, Foreign "			0 6 8	1.62
	Small coal and culm, British "			0 2 0	0.48
	Small coal and culm, Foreign "			0 4 2	1.00
to 1834, 15 Aug.	Duty repealed, and in lieu an ad valorem duty of 10s. per £100, British vessels.				
	The duty ceased 15th Aug. 1834, foreign vessels,			0 4 0	1.00
1834 to 1842.	The English duties on foreign exports of coal were remitted altogether 15th Aug. 1834; except as regards Russia and Holland; these states not recognizing the reciprocity duties.			Free.	Free.
1842	Large coal, British vessels to for'n countries,			0 2 0	0.48
	Large coal, Foreign "			0 4 0	0.96
	Small coal and culm, British vessels to for'n countries,			0 1 0	0.24
	Small coal and culm, Foreign "			0 2 0	0.48
	With the additional charge of 5 per cent.				
	The tariff of 1842 was found to have a baneful effect upon the trade; and it enabled coal miners of France, Prussia, and Belgium to advance their produce, and to compete in foreign markets with the English coals.				
1843	By Treasury letters, the shipping of several foreign countries were admitted to ship English coal on the same footing as British vessels.				
1845, May 8th.	The export duties on coal and culm in British vessels were removed.				Free.

Note.—With regard to these tables of import and export duties, it seems impossible to form positively correct returns. Even the official parliamentary records abound in discrepancies, although they are seldom of material importance.

Culm is either the small of anthracite, or a mixture of all sizes, as they were mined.

Coke is locally termed *cinders* in certain coal-fields, and is so returned in the tables of exportation.

Comparitive table or statement of the *import duties* levied by the principal European countries previously to 1842; prepared with some modifications from the speech in Parliament of Sir Robert Peel, in June, 1842.

Countries.	In 1837 per ton *s.* *d.*	In 1842 Per ton. *s.* *d.*	U. S dollars.
France, southern ports, French vessels,	2 9	2 9	= $0.62 [duties.
France, southern ports, foreign "	6 5	6 5	= $1.55 besides other
France, northern ports, French "	4 0	0 10	= $0.19 [charges.
France, northern ports, foreign "	8 0	4 0	= $0.95 with other
Kingdom of the two Sicilies,		Free.	
Russia,		Free.	[Nov. 1842.
Holland, formerly a prohibitory duty, (fixed at 7 florins in 1822,) of 10s. 1d.	6 10	6 10	= $1.65 abandoned
Belgium, from France,	2 9		
Belgium, from other countries,	11 8	Free.	taken off in 1839.
Denmark,	2 5	3 0	= $0.72
Sweden, (wholly abolished 19th Oct., 1843,)	10 0	4 0	= $0.96
Prussia,		3 0	= $0.72
Hamburg, 1¼ per cent, *ad valorem*,			
Portugal, 15 per cent. *ad valorem*,			
Brazil,		8 0	= $1.92
England, in British vessels,	Free.	2 0	large = $0.48
England, to all ports except Holland and Russia,		1 0	small = $0.24
England, remitted altogether in 1845,			free.
England, for British shipping,	4 2	4 0	large = $0.96
England, in foreign ships,		2 0	small = $0.48
United States of America, $1.68	7 0	7 3½	= $1.75

By virtue of a treaty concluded with Great Britain in 1837, and of a more recent convention of the fifth November, 1842, with Belgium, the kingdom of the Low Countries [Holland] admitted the vessels of the two former states on the same footing as her national vessels. Hence it follows that the entry of coal in Holland may be considered as free.

Effect of the Remission of the British Tariff duties on Coal, in 1845.

The effect of the alteration of the tariff, in facilitating the trade in coal between Great Britain and France, will be seen from the following statement:

From 1813 to 1834, while the Belgian coals, received coastwise, were taxed by France with a duty of only 2*s.* 9*d.* per ton, those of England were charged 13*s.* 9*d.* per ton. In 1834, the French duty on the English coals was reduced to 8*s.* per ton, and the Belgian duty was equalized; at the same time, the English export duty was taken off altogether.

The immediate influence upon the coal trade of the three countries was remarkable. During the three years succeeding 1834, the English coals almost entirely replaced, *along the coast* of France, not only the Belgian, but the indigenous coals, which had previously been shipped, coastwise, in great quantities from the port of Dunkirk. In the interior, the importation of Belgian coal continued to advance, though less quickly than the English.

		Metrical Quintals.		English Tons.
In 1834	British coals imported into France,	489,438	=	48,267
	Belgian and French indigenous coals exported from Dunkirk to other French ports,	530,860	=	52,350
	Entire imports from Belgium,			620,008

		Metrical Quintals.	English Tons.
In 1837	British coals imported into France,	2,226,057 =	219,527
	or by the English returns,		272,133
	Belgian and indigenous coals sent from Dunkirk, coastwise, to other French ports,	99,365 =	9,798
	*Entire imports from Belgium,		780,429
In 1842,	British coals imported into France,		515,975
" 1843,	do. do. being now subject to an export duty, only amounted to		458,594
" 1844,	do. do. still lower amount,		412,902
" 1845,	do. The export duties wholly removed,		647,967

In 1845, the absurd English export duty of 4*s*. per ton on coals was taken off; and the effect produced on the general trade was a greatly increased exportation; advancing from 1,698,481 tons in 1844, to 2,531,282 tons in 1845, or 49 per cent. increase in that year.

Comparative prices of English and Foreign Bituminous Coals delivered including the British duty of 1842, *of two shillings per ton.*

				s.	*d.*	*dolls.*
In 1842,	At Rouen,	English coal could be sold for		29	0	7.02
		Belgian	do.	28	0	6.78
	At Rotterdam,	English	do.	16	6	4.00
		Belgian	do.	16	9	4.05
	At Marseilles,	English	do.	23	3	5.62
		French	do.	23	3	5.62
	At Havre,	English	do.	23	0	5.50

Abrogation of the duty on Exported Coal, since the Tariff of 1842.

In June, 1844, an attempt was made by Lord Harry Vane, in the House of Commons, to abrogate the tax imposed, in 1842, on exported coal. The reasons assigned for the proposition were, the admitted embarrassments of the coal trade; the insignificant produce of the duty—particularly as at the present time there was a surplus revenue. When the export duty was taken off, in 1835, the foreign trade continued to increase, until the re-imposition of the duty in 1842, and the new tax had left a greater displacement of labour and capital, than if the old duty had been left on. In 1842, the quantity exported to foreign countries [exclusive of the colonies,] was 1,664,450 tons; in 1843, it was 1,547,000 tons, although the demand on the continent had increased. Another effect of the duty was, that northern countries, which formerly took unscreened coal, now take small coal, which returns the smallest amount of profit to the trade. The duty caused the greatest distress in the trade, having deprived the people of one day's labour in the week.

The proposition was opposed by the Chancellor of the Exchequer, who disputed Lord Harry Vane's statements.

He questioned the diminished exportations. If the year 1841 were compared with 1843, it would show an increase, and the latter was the fair and proper comparison to make; because in the year 1842 the trade was affected

* Résumé des Travaux Statistiques de l'administration des mines, en 1838. There are some unimportant discrepancies between the official returns of France and those of England.
† Dunn, p. 232.

by the announcement, made in March, that the coal duties were to be altered; as was proved by the fact that the exports in the earlier half of that year, exceeded by some hundred of thousands those in the latter half.*

He questioned whether the duty had affected the trade at all; and instanced the corresponding decline in the amount exported to the colonies where there had been no variation of duty.

Again, as to the quantity sent from other ports to London, to which there had also been no variation of duty, there was also a diminution.

It had been formerly said, that the duty would ruin the trade with France, but it had increased since 1841; also that with Russia.

The persons interested in the coal trade used to complain that they could find no market for their small coal. Since the alteration of the duty, the amount of small coal exported, had increased from 148,000 tons in 1842, to 456,000 tons in 1843.†

Yielding to the earnest remonstrances of those who were engaged in the trade, the Minister, in 1845, removed all the export duties on coal. The beneficial effect of that salutary measure was immediately experienced. The consequent increase in the export trade, was as follows:

The entire United Kingdom, forty-nine per cent.; port of Stockton on Tees, twenty per cent.; Newcastle, seventy-six per cent.; Sunderland, ninety-five per cent.

The following abstract will suffice to show the general character and distribution of the coal which is annually exported from England and Wales to foreign countries and British possessions abroad.

Places of Exportation	Dates.	Tons.	Places of Exportation.	Dates.	Tons.
To Belgium,	1834	270	To Denmark,	1828	61,392
	1838	2,270		1834	72,186
	1840	4,430		1837	92,275
To Russia,	1810	2,316		1840	126,779
	1817	6,426		1841	151,146
	1831	31,379		1844	140,608
	1834	35,214		1845	168,158
	1839	78,054	To Holland,	1831	123,445
	1840	93,370		1834	94,447
	1841	77,152		1836	127,833
	1844	94,144		1839	180,340
	1845	150,422		1840	205,757
To Sweden,	1831	6,150		1841	206,060
	1834	11,658		1844	97,970
	1840	21,532		1845	139,288
	1841	26,941	To France,	1788	184,773
To Norway,	1831	3,774		1802	9,860
	1834	3,573		1820	24,800
	1838	14,630		1830	50,340
	1841	15,894		1832	37,530
To Italy,	1836	20,642		1833	41,640
	1838	26,709		1834	48,943
	1844	65 003		1836	167,170
	1845	97,338		1838	304,600

* The real amounts are these—1841, 1,848,294 tons; 1842, 1,999,504 tons; 1843, 1,845,861 tons; 1845, 2,531,282.

† Parliamentary Debate.

Places of Exportation.	Dates.	Tons.
To France,	1840	394,954
	1841	451,003
	1842	515,975
	1843	458,594
	1844	412,902
	1845	617,967
First 9 months of	1847	1,026,000
To Portugal,	1831	6,402
	1837	20,966
To British possessions, [aggregate]	1819	71,497
	1825	110,264
	1834	177,721
	1841	341,729
	1843	307,000
	1844	278,943
	1845	375,302
To Germany,	1831	44,033
	1834	50,258
	1836	66,720
	1838	100,960
	1840	121,391
	1841	173,437
	1844	171,865
	1845	227,539
To Prussia proper,	1831	15,956
	1834	23,787
	1837	49,925
	1841	116,296
	1843	148,197
	1844	95,306
	1845	184,487
To Egypt,	1842	7,260
	1843	13,000
	1844	23,866
	1845	48,063

Places of Exportation.	Dates.	Tons.
To United States of America,	1831	15,103
	1834	39,855
	1836	30,220
	1837	46,574
	1838	57,175
	1839	52,930
	1840	77,559
	1841	52,273
	1842	68,407
	1844	29,832
	1845	58,381
	1846	57,903
To East Indies and Ceylon,	1830	4,043
	1832	6,473
	1841	63,920
	1844	28,231
	1845	85,689
To British West Indies,	1831	48,536
	1840	82,564
	1841	71,311
	1844	77,338
	1845	102,339
To Foreign West Indies,	1844	26,592
	1845	22,154
To Malta,	1844	48,546
	1845	52,327
To Turkey and Greece,	1844	34,448
	1845	56,776
To Algiers,	1844	17,564
	1845	20,889
To British North America,	1844	58,928
	1845	79,359
To Brazils,	1844	20,601
	1845	30,038
To Channel Islands,	1844	65,900
	1845	55,588

Many of the smaller exportations are generally classed together, and are not separately enumerated in the returns usually published.

GENERAL EXPORTATION.

Parliamentary Returns of the Exports of Coal, Culm, and Coke, shipped from the ports of the United Kingdom to foreign countries, and to British settlements abroad; and the Declared Value thereof, on ship-board.

The English commercial and financial year closes on the 5th of January.

Coals Exported—subject to Duties which were repealed, Aug. 15, 1834.				Coals Exported, Duty Free from 1834 to 1842.			Coals Exported, and subject to Duty.		
Years.	Tons.	Years.	Tons.	Years.	Tons.	Declared value.	Years.	Tons.	Declared value.
1819	235,872	1830	504,419	1835	736,060	£244,898	1842	1,999,504	£733,574
1822	284,576	1831	510,831	1836	916,868	322,861	1843	1,845,861	690,424
1825	311,498	1832	588,446	1837	1,113,610	431,545	1844	1,754,171	672,946
1828	356,864	1833	634,448	1838	1,313,709	485,950	Exported, Duty Free.		
1829	371,271	1834	615,255	1839	1,449,417	542,609			
				1840	1,606,313	576,519	1845	2,531,282	£973,635
				1841	1,848,294	675,287	1846	Free.	Free.
					First nine months of 1847				735,165

Table of the annual Revenue, or amount of Duty received by Great Britain from sea-borne coals of the United Kingdom EXPORTED to foreign ports.

Before the Duty was taken off in Aug 15, 1834.		After the Duty was taken off, Aug. 15, 1834, to March, 1842.		Subject to the Tariff of 1842.*	
Years.	Duty.	Years.	Duty.	Years.	Duty.
1828	£34,450	1835	£ 5,001	1842	£ 57,415
1829	37,500	1836	8,667	1843	131,304
1830	56,900	1837	8,910	1844	118,000
1831	50,000	1838	7,632		
1832	64,710	1839	8,600	Duty removed in 1845.	
1834	35,000	1840	6,900	1845	£ 17,272 -
		1841	11,925	1846	Free.

For a table of the annual amount and value of Coal exported from Great Britain to France, see France.

Return issued in pursuance of the order of the House of Commons, June 17, 1847, of British vessels laden with coal, culm and cinders, for the six years preceding 1847, and entered outwards, from the several ports of the United Kingdom.

Years.	Number of British ves'ls.	Foreign vessels.	Total Number.	Duty paid by British ves'ls.	Duty paid by foreign ves'ls.	Total duties.
1840	5,275	3,820	9,095	£ 1,539	£ 5,559	£ 7,098
1844	5,954	4,095	10,049	73,655	40,525	114,180
1846	7,223	5,578	12,801	None.	None.	None.

Increase in these six years, 142 per cent.

ROYALTIES, TRIBUTE, RENT, OR GALEAGE, IN THE ENGLISH COAL-FIELDS.

In an account of the Newcastle coal-field, communicated by M. Piot to the *Annales des Mines*, the subject of royalties and leases in the English coal mines is not overlooked. We make a few notes from that article, premising that they have the disadvantage of a double translation, from the English and French languages.

Of the 48 coal mines upon the Tyne, the author states that five only are worked by their proprietors. The rest are leased to one or several adventurers; the stock being divided into a certain number of parts, which never exceed sixty-four. This stock is apportioned between the members of the company, at their convenience; and each individual is responsible in proportion to the amount of interest he holds in the enterprise.

All these leases are established upon a common principle, and for a period of from 21 to 40 years. The proprietor of the soil receives a rent, to which the name of *Royalty* has been given, and which is determined in the following manner:—The probable profit of the enterprise is first estimated, with as much exactness as possible. This profit is regarded as a sum resulting from the accumulation of a capital and its interest during the duration of the lease. They then calculate the annuity which it ought to pay, to com-

* Taxation and the funding system, by J. R. McCulloch, 1844, p. 486.

pletely reimburse this capital and interest, at the end of a term a little shorter than that to which the lease extends—19 or 20 years, for example, if the lease is for 21 years. This annuity constitutes the rent, which the proprietary ought to receive.

The royalty is not an entirely fixed sum: it varies with the products of the mine. With regard to coals, it used to be based upon the *measure* or number of chaldrons: but since 1834 it is now fixed at so much per ton *weight.*

The proprietors' rent, tribute, right, or royalty, varies from 5 pence to 18 pence [0fr. 52c. to 1fr. 75c.] per Newcastle chaldron, of 2 tons 13 cwt., each.

Upon the Tyne the maximum is one shilling and three pence per chaldron, and its minimum is two pence. The mean royalties, for the districts of the Tyne, the Wear, and the Tees, is 5 or 6 pence per ton.

Sometimes at the commencement of a work, the owner undertakes to renew the lease for a second period, but that practice is not common.*

On the continent of Europe, the royalties press more heavily upon the coal producer than in England. In Bohemia the established right, by law, is that the "Seigneur" receives the tithe [10th] of all the coal raised: in other words, for every ten tons extracted, one tenth is the property of the lord. In the coal basin of Blanzy, in France, it appears, from registers from 1528 to 1640, that the lords of the soil exacted one third, and sometimes two thirds, of all the coal raised in the mines there. They are now from 1-10th to 1-40th.

In the English mining districts the lord's tribute varies according to the local circumstances of the mine, from 1-10th to 1-32d part of the whole produce of the ore.†

In the Isle of Man the mines pay a royalty of one tenth.

In the United States of America, the relations of lessor and lessee can scarcely be said to be adjusted.

MINING LEASES IN THE NEWCASTLE COAL FIELD.

Under this head, we shall quote the entire passage in Mr. Dunn's account of this coal-field. "The general mode of letting collieries, throughout the whole of the district, is by the ten of 440 bolls=18⅓ Newcastle chaldrons, of 53 cwt. each; [?] a certain annual rent being payable, half-yearly, on account; calculated at about ⅔ the expected yearly tonnage amount. The rate of royalty, thus reserved, varies from ⅛ to 1-20th of the net value raised, according to the capital embarked, and other circumstances. It does not necessarily occur that the most valuable collieries are let at the highest rates; by reason of the enormous capital required to establish some of them.

As the lessees are made to pay, half-yearly, a proportionate certain rent, so are they allowed to make up for such advance, out of the workings of succeeding years. [This is called *making up shorts.*] But it often happens that unforeseen difficulties so hamper the lessees, that the shorts are never made up; and, in such cases, the landlord both saves his mine and pockets the adventurers' money.

To guard against casualties, power is reserved, by lessees, to vacate the colliery, by giving twelve months' notice; but they are bound to leave it in

* Annales des Mines, Vol. I. 1842.

† Mr. John Taylor on the Mining Economy of Cornwall and Devon. Geol. Trans. Vol. II. old series.

an open and tenantable state. They are also liable to all damage done to the surface, in the course of working."*

Leases of Coal Mines in Cumberland.—Precisely the same as in the Newcastle district.†

Leases in Yorkshire and Lancashire.—"The seams of coal being specified, a certain annual rent is agreed to, *per foot thick per acre*, and the tenant agrees to work away, or pay for, an agreed number of acres per annum.

At the end of each year, a plan and admeasurement is made of the quantity so taken, in order to ascertain the rent: each year's working being coloured differently. The amount of rent ranges from £50 to £100 per acre per annum. Taking a three feet seam (at a ton per cubic yard,) to contain 4840 tons, three quarters of which are producible=3630 tons; and they to be sold at 5*s.* each, it would amount to £907; in which case £100 would amount to 1-9th, or about 6½*d.* per ton."‡ Mr. Dunn, however, considers that this principle is by no means so clear and practicable as by the ton, or by the amount of sales; because the preparatory workings of a colliery are in no shape to be measured.

Way-Leaves.—Owners and lessees of coal mines, are often necessitated to obtain permission to pass through intermediate lands. In this case, a treaty is entered into for this right of passage, and the rent agreed on is termed the *way-leave.* Of course it is very variable in its amount; and in the cases where the lands of several proprietors must be traversed by a railroad, the dues or charges are often very considerable. Thus, it is very advantageous to be located in the vicinity of a public way.

When several mines use the same railroad, they pay a toll or rent to the party who has constructed it, and at the same time another to the owner of the soil. The way-leaves vary from 2½ pence to 2⅓ pence per ton, per mile: the mean is about two pence.

The mine which pays the highest rent or toll for the establishment of a way-leave road, gives 3*s.* 9*d.* per ton, transported to the point of shipment. In this same mine, the rent has varied from 3*s.* 6*d.* to 2*s.* and 6*d.*, according to the number of tons extracted.

The first cost or payment made on these roads, or way-leaves, extends to £350 [8750 francs] per mile. The road from Stanhope to the Tyne, £250 [6250 francs] per mile. A mile of road occupies an area of six acres; and the land costs from £300 to £400 an acre.§

In the progress of the parliamentary inquiry in 1836, a considerable amount of evidence was given on the subject of way-leaves. It appeared that the tonnage rates varied from 1*d.* up to 3*d.* per ton per mile.||

Prepared Fuel,—composed of various proportions of coal-dust, peat, coal tar, or other combustibles and clay or argillaceous matter; see numerous details, collected under the heads of South Wales, Holland, China, Flanders, Ireland, &c.

Assessing of the Coal Mines in Great Britain for Rates and Taxes.—This being a species of property, liable like any other to the operation of taxation, has at times been brought under the consideration of the legal profession and the county magistracy, in the mineral districts.

* Dunn. Hist. of the Coal Trade, 1844 p. 171.
† Ibid.—p. 134.
‡ Ibid.
§ Annales de Mines, M. Piot, Vol. I. 1842, p. 141.
|| Parliamentary Report on the Coal Trade in 1836.

Collieries are subject to two distinct principles of rating; governed by different rules, and subject to different allowances or deductions: and it is advisable to keep these two subject matters distinct, in the rating.

We cannot enter into details here, beyond showing, from the report of Mr. Bicheno, to the magistrates of Carmarthenshire, S. Wales, the principle adopted, in the rating of coal mines. Although, it was allowed, no uniform principle has been preserved throughout the country.

I. *Coal Mines.*—That which is rated here is the underground operations for obtaining one of the natural products of the earth, with the machinery; and can claim no allowance for repairs or insurance.

The *Royalty, Rent, or Galeage*, paid to the proprietor, becomes the criterion of the rateable value of a *coal mine*; subject, of course, to the review, of what is the value at the time of rating.

II. *The Surface Land* lying out of, or above, the mines: that which is occupied by railroads, tramroads, engines, machinery, and the like. From its value, a liberal deduction should be made for repairs, to maintain them in a state to command the rent. They may sometimes be a part of the mine; sometimes not: in either case they are liable to be rated.

Provident Institutions—Casualties and Diseases of Colliers and Miners.—See some statistics collected together, in the introductory portion of this volume.

With regard to government interference on the subject of accidents incident to the working of the mines, Mr. Dunn observes, "I am free to acknowledge, that well digested measures of legislation would not only be beneficial to the owners of mining property of every description, but would also tend, very materially, to save the lives and limbs of the people, as well as to advance their civilization and intellectual attainments."*

The number of persons engaged in coal mining is upwards of 500,000.

Wire Ropes and Cables.—See some valuable details collected together under the head of Prussia.

Besides these, we would refer to some valuable communications, during the last ten years, in the Mining Journal of London; also in the American Railroad Journal, and in the Journal of the Franklin Institute, Philadelphia, for some time past.

Weight of English Coal.—Usage of the Trade.—The average weight of the Wall's-end coal is stated to be 78,945 lbs. per cubic foot. Specific gravity, 1.263; weighing 28 cwt. 8 lbs. per London chaldron.

The London chaldron is sometimes estimated at 26½ and sometimes 25½ cwt., in the trade, but all these discrepancies have terminated, since the practice of selling coal by measure, instead of by the ton, has been abandoned. The various weights, measures, and denominations employed under the old system are detailed in our preliminary tables. The respective density of all the British coals appear in the tables of analysis at the end of this work.

Profits of the Coal Miner.—While the owners of the coal lands have accumulated large fortunes, from the rental of their coal in the mine, it does not appear that the operative miner and the merchant have been equally fortunate. The great competition in this mineral fuel may have produced the effect of diminishing the producers' profits, and of confining them to moderate limits.

Instead of the business of coal mining being, generally speaking, an ad-

* Dunn's History of the Coal Trade, p. 221.

vantageous one, it is distinctly stated to be the reverse. Sometimes, no doubt, large fortunes have been made by individuals and associations engaged in this business; but these are rare instances. The opening of a mine is a very expensive and hazardous operation, and of very uncertain result.

Collieries are exposed to an infinite number of accidents, against which no caution can guard. Besides explosions, which are every now and then occurring from the carelessness of the workmen, and other contingencies, mines are very liable to be destroyed by *creeps*, or by sinkings of the roof; and by drowning, or the irruption of water from old workings, through fissures which cannot be seen; and consequently, cannot be guarded against. So great, indeed, is the hazard attending this sort of property, that it has never been possible to effect an insurance on a coal-work against fire, water, or any other accident.*

Mr. Buddle states that "although many collieries, in the hands of fortunate individuals and companies, have been, perhaps, making more than might be deemed a reasonable and fair profit, according to their risk, like a prize in a lottery, yet, as a trade, taking the whole capital employed, he should say that it has certainly not been so."

"According to the best of my knowledge, I should think that *by no means* 10 *per cent. has been made at simple interest, without allowing any extra interest for the redemption of capital.*"† We have reason to think that such is the experience on the American side of the Atlantic, during the last five or six years.

Mr. Clayton's evidence before the parliamentary committee in 1800, on this head, was to the same effect. He stated, "I have possessed the means, and have had frequent opportunities of adventuring in speculations [in coal]. I have ever declined doing so, upon the principle that the average profits resulting from those adventures, were inadequate to the employment of so much capital as they required, and to the risk attending them."‡

Table or Summary of the Fifty-one Coal-fields of Great Britain and Ireland, specifying their respective areas in square miles and English acres, and numbered in correspondence with the accompanying map.

	1. ENGLAND.	Square miles.	Acres.	Remarks.
1	Devonshire culm or anthracite region,	1,110	710,400	a small portion only contains [workable coal.
2	Bristol coal-field, { 1. Northern tract. 50; 2. Central or Pensf. 7; 3. Southern, 6; 4. Eastern, 2; 5. Western, 5; 6. Ov'lying Sandst. 130 }	200	128,000	the seams are generally thin, but numerous, and of fair quality. [strata, 56 s. m.
3	Forest of Dean, excellent coal,	45	28,800	space occupied by coal bearing
4	Newent,	2½	1,600	coal disturbed.
5	Bewdley and Billingsley, or forest of Wyre, Worcestershire,	67	42,880	coal generally impure.
6	Tillerstone Clee Hill, S. Shropshire,	8	5,120	occasionally faulty.
7	Brown Clee Hill, Shropshire,	2	1,280	coal somewhat inferior.
8	Lickey Hill. Worcestershire,	1	640	not much worked.
9	Warwickshire coal-field,	60	38,400	Thirty feet of coal. [56 s. m.
10	Ashby de la Zouch, Leicestershire,	62½	40,000	by other accounts, 35,840 acres or
11	Dudley coal-field, South Staffordshire,	100	64,000	by other ac. 90 s. m. very valuable.
12	Coalbrook Dale, Shropshire,	32	20,480	of good repute, but subj. to faults

* Statistics of the British Empire, Vol. II. p. 8.
† First report to House of Lords, p. 56.
‡ Parliamentary Enquiry, 1800.

	1. ENGLAND.	Square miles.	Acres.	Remarks.
13 A	Shrewsbury coal-field, Shropshire,	25	16,000	upper coal measures.
13 B	Oswestry coal-field, Shropshire,			area not defined.
14	Pottery coal-field or N. Staffordshire, Newcastle under line,	63	40,320	30 to 40 coal seams.
15	Cheadle coal-field, N. Staffordshire,	15	9,600	
16	Darley Moor, Derbyshire,	1	640	
17	Shirley Moor, Derbyshire,	1	640	
18	Manchester great coal-field, Lancashire and Cheshire,	600	384,000	from 550 to 600 s. m.; important.
19	Kirby Lonsdale or Ingleton coal-field, Yorkshire,	4	2,560	
20	Great Central Coal-field S. Yorkshire, Nottingham and Derby,	1,010	646,400	an area of moderate importance, but poss'ng some fine coal s'ms.
21	Mill-stone Grit Range, Yorkshire, Lancash'e,	750 250	640,000	chiefly thin veins.
22	Appleby, 3 detached small fields, Westmoreland,	26	16,640	
23	Whitehaven coal-field, Cum'd,	120	76,800	a very valuable coal-field.
	Aketon, det'd field to North, do.	4	2,560	
24	Oolite coal region, Yorks. Moorlands,	150	96,000	Lignite or coal of inferior quality.
25	Newcastle field, Durham and North'd,	780	499,200	other authorities, 837 s. m. = 535,680 acres, the most important of the English coal-fields.
26	N. of England, Durham or Berwick,	20	12,800	coal of fair quality.
27 a	Millstone Grit & lower coal, North'd,	530	339,200	coal of second rate value.
	Total, exclusive of Bovey coal, 6,039 sq. m. = 3,864,960 acres,			and including the culm and the Yorkshire oolite coal.
	2. SCOTLAND.			
27 b	Dumfriesshire, Canobie, &c.	70	44,800	valuable detached coal-areas.
28	Great Central Scottish coal, Area, 1,650 sq. miles. — Lanarkshire field,			about 650 s. m. in all. 20 or 30 beds.
29	Basin of the Clyde,			contains 84 coal-beds.
30	Johnstone coal field,			10 coal seams, amounting to 100 ft.
31	Mid. Lothian field,	1,650	1,056,000	the 24 edge seams, 94 ft. aggregate
32	East Lothian c'l field,			50 to 60 coal-beds—in all 188 feet.
33	Kilmarnock do.			contains anthracite or glance coal.
34	S. W. or Ayrs're reg.			contains about 51 feet of coal.
35	Fifeshire region,			142 distinct coal seams in the Clackmannan district.
36	Brora Oolitic coal, Sutherlandshire,			area not defined.
	Isle of Mull do. unimportant,			do.
	Isle of Arran do. do.			do.
	Total in Scotland, 1,720 s. m. = 1,100,800			exclusive of the Brora coal.
	3. NORTH WALES.			
37	Isle of Anglesea, main coal belt,	18	11,520	beds thick and of good quality.
38	3 other insulated patches, Menai S'd,	7	4,480	
39	Flintshire c'l-fi'd. C'l fi'd, upper beds,	105	67,200	contains some excellent coal veins
	do. lower do.	80	51,200	Grit and lower measures.
	In North Wales, 210 s. m. = 134,400 ac.			
	4. SOUTH WALES.			
40	S. Wales coal basin, Glamorganshire, &c.	950	608,000	anthracite and bituminous coals. 84 seams, from 1 inch to 9 ft. thick.
	5. IRELAND.			
41	Antrim or Ballycastle coal fi'd, Ulster,	250		bitum'us coal—little investigated.
42	Dungannon coal basin, Tyrone, do.	250		do. of good quality.
43	Area, west of this do. do. do.	15		do.
44	Monaghan field, do.	200		bituminous seams are thin.
45	Cavan county, do.	15		do.
46	Leitrim. Connaught,	300		bituminous—imperfectly known.
47	Carlow, Queen's county, and Kilkenny, Leinster,	240	1,881,600	anthracite or Kilkenny coal.
48	Kilkenny, a small area, do.	20		anthracite and culm.
49	Killenaule or Tip'y, Clare in Munster,	140		anthracite.
	A small area to the south-west, do.	10		do.
50	Clare, North Munster,	500		do.
51	Limerick, South Munster,	1,000		do. not much investigated.
	Several areas of brown coal or lignite in Antrim,			not included.
	Total in Ireland,	2,940		These areas are only approximate.

The total area of coal measures in England, Scotland, Wales, and Ireland, is therefore, as follows, viz.

	Area of coal measures only.		Entire Area.		
	Square miles.	Acres.	Acres.	Square miles.	Prop. of coal to the whole.
In England, - - - -	6,039	3,864,960	31,770,615	49,643	1-8th
In Scotland and Islands, exclusive of Lakes, - - -	1,720	1,100,800	18,944,000	29,600	1-18th
In North Wales, - - -	210	134,400	4,752,000	7,425	1-6th
In South Wales, - - - -	950	608,000			
In Ireland, - - - -	2,940	1,881,600	20,399,608	31,874	1-18th
In British Isles, - - -			1,119,159	1,748	
	11,859	7,589,760	76,985,382	120,290	

Exclusive of wood coal and lignite formations, and some small undefined areas.

ENGLAND.

DEVONIAN SERIES.

I. CULM, OR ANTHRACITE FORMATION OF DEVONSHIRE.

This culm district was not formerly classed with the English coal-fields, but the investigations which were made in 1837, pointed out the necessity of that arrangement. The memoirs of Messrs. Murchison and Sedgewick, in Vol. V, of the Geological Transactions, shows an area of about fourteen hundred square miles occupied by the culm measures; although the actual amount of coal therein seems to be very inconsiderable.

At Biddeford, near the north-west angle of this area, are many old workings on three seams, of two, three, and four feet, respectively, in thickness. On the east side of the region the attempts to work the culm beds have hitherto failed to reward the adventurers with any profit. It is broken up in contortions, and an incredible number of anticlinal and synclinal lines: a circumstance of itself sufficient to prevent any advantageous system of operations.

This region was described, in 1834, by Sir H. T. De la Beche, who showed that the maximum thickness of anthracite was about twelve feet. Messrs. Sedgewick and Murchison ascertained that the culm measures occupied a trough of considerably greater extent than had been supposed; resting on silurian rocks to the north, and on granite and the old slate rocks of Dartmoor to the south. Three beds of culm are worked. The best averages nearly four feet in thickness; but in some places it swells out to nearly twenty feet.

Taking our admeasurements from Mr. Greenough's beautiful geological map, we find that the carboniferous area occupies eleven hundred and ten square miles; a small portion only of which is productive. The coal plants had been conceived by Mr. Lindley to be identical with those usually found in the regular coal-fields, but the result of more recent investigations have determined the fact that the culmiferous series, which occupies one-third of

the county of Devon, and a considerable part of Cornwall, characterizes an intermediate group, now known as the Devonian, between the Silurian series and the main coal measures.

A paper by Mr. Austen, in 1837, "on the geology of the south-east of Devonshire," enters into additional details on this ancient carboniferous series.

In January, 1838, another article was communicated to the Geological Society, "on the geological relations of North Devon." The author concurred in the opinion that it was perfectly correct to remove this coal system from the transition series, to which it had been assigned, and to place it with the associated regular coal strata.

In May, 1838, appeared another paper devoted to "the culm measures," by Professor Sedgewick, which showed that the error of confounding them, formerly, with the oldest rocks of Devonshire and Cornwall, probably arose from their metamorphic character.

In 1839, was published Sir Henry T. de la Beche's "Report on the Geology of Cornwall, Devon, and West Somerset;" a volume of great scientific and practical value. The area of the culmiferous measures, comprises a variety of sedimentary deposits, anterior to the true coal measures, and all these were provisionally classed by the author under the head of "Carbonaceous Deposits." The upper part of this series contains a greater amount of carbonaceous matter than the lower; but carbon by no means is abundant in either. The worked beds, the importance of which has been most remarkably magnified, are generally accompanied by black shales, among some of which are found the abundant remains of plants. The anthracite is much mixed up and interwoven with these shales, seeming to be the result of vegetable matter intermingled with mud and sand, and with nodules of argillaceous iron ore. The author adds, that notwithstanding Dr. Lindley was satisfied that the general form of these plants resembles that of the vegetation observed in the coal measures, many species, and even one genus, were entirely new to him, and were different from any he had noticed among the plants of the coal measures. Leaves of monocotyledonous plants, of three or four species, hitherto undescribed, constitute the great proportion of the vegetation entombed within this carbonaceous range of rocks, and, no doubt, contributed most materially to the formation of the anthracite. We are further assured that a large proportion of these plants appear to belong to species not yet known in the true coal measures; and that, probably, one half of the same mass is made up of the leaves of plants of which the genera have not yet been determined.*

We have thus briefly traced the progress of these investigations, because of the geological interest which attaches to them, and because they exemplify, in an instructive manner, the occasional difficulties which attend the determination of the relative age of certain formations.

Old Red Sandstone group.—The rocks which have received this designation, and which, for a time were thought to be limited to a very small part of the surface of England, have acquired importance from the wide area which modern discovery assigns to them.

Sir R. Murchison, and his associates have pointed out the existence and perfect identity of rocks of this epoch with those of the British Isles, extending over an area of not less than one hundred and fifty thousand square miles in European Russia; a superficies greater by nearly one-third than that of Great Britain and Ireland together.

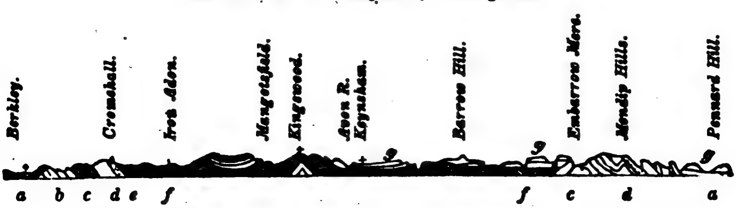
* Report of the Geology of Devon, &c. p. 101 to 126.

In North America we know that a portion of the series extends in one direction many hundred miles; and is extensively displayed in Pennsylvania, although in general containing few terrestrial plants. In the old red sandstone group, intermediate between the Silurian series and the carboniferous formation from which it is separated by an irregular thickness of red shales and sandstones, we find an irregular deposit of anthracite, sometimes characterized by splendid fossil coal plants. We have attended the progress of mining researches on one of these coal beds, which exhibited an extremely irregular development of carbonaceous matter, at one time five feet thick, and again diminished to a few inches, or thinned off altogether. It would be an interesting investigation to ascertain the comparative details of the fossil vegetation of this group, probably the lowest in the geological scale, in America, which forms an anthracite. It is true, the cupriferous vegetables, in the red shales of the next formation below, show the presence of terrestrial plants at that early epoch; but the upper Silurian or Devonian series appears to be the first or oldest carbonaceous deposit, on that continent.

II. BRISTOL COAL-FIELD.

Fig. 18.

Section of the Bristol Coal-field, in its longest diameter, from N. to S. by Dr. Buckland and Rev. W. D. Coneybeare, looking east.



a a New Red Sandstone.
b Transition Limestone.
c Old Red Sandstone.
d Mountain Limestone.
e Millstone Grit.
f Coal Measures and Pennant Grit.
g Lias.

Bristol Coal-field, described by Messrs. Buckland and Coneybeare.* The principal field occupies about fifty square miles, or 32,000 acres, besides numerous insulated members, on the west and south, spread over a much greater area, at least double in extent, in the aggregate. They have been generally arranged as five principal coal tracts.

There is no scale given to the map accompanying these gentlemen's paper, but with the assistance of Mr. Greenough's last map, we have ascertained the following areas.

1. The northern coal tract,		-	50	square miles.
2. The central	do.	or Pensford,	7	do.
3. The southern	do.	- -	6	do.
4. The eastern	do.	- -	2	do.
5. The western	do.	- -	5	do.

Showing seventy miles of exposed coal strata; but as a vast many working shafts are sunk through the overlying sandstone, the effective coal area is probably not less than two hundred square miles, or 128,000 acres; the

* Geol. Trans. London, Vol. I. Second series, Buckland and Coneybeare. Also Mr. Weaver's paper, same Vol. p. 345.

entire space may be compared to a group of islands emerging from shallow water, or to hummocks in a Florida swamp.

The number of collieries in work formerly was probably greater than it is at present, though the total produce of the mines is certainly much greater now than at any former period. The enlarged scale and spirit with which those mines are worked, that are now in activity, much more than compensate for the diminution in numbers.

The seams of coal are very thin, in comparison with those which are worked in the principal English coal-fields, and in most of such would be passed over as unworthy of notice. The aggregate thickness of the seams worked, in any single coal pit scarcely exceeds that of one of the ordinary seams in the principal districts; and the total of all the beds in the mining-field would be little more than double of the largest main of Staffordshire. That seams so thin should be sought for, through lias and oolite, at the enormous depth of two hundred fathoms, must excite surprise, in those acquainted only with other coal districts. That, under these circumstances, the seams should be worked with profit, must be attributed chiefly to the highly improved machinery introduced into this district; the result of which is, that the quantity of coal delivered at the mouth of one of these pits, in a single day, averages at from 60 to 100 tons.

The district may be considered as able to answer largely the future demand; for 1st, most of the ancient pits, now abandoned, might be drained, and worked to advantage on the present improved system; 2dly, much of the area is still untouched. It is also considered extremely probable, that considerable coal areas, now unobserved, and covered with the newer formations, extensively exist in that section of the country.

26 sections of the worked portions of these coal areas, have long since been published, by the authors of the paper which we quote. How many seams of coal exist altogether, does not appear, but they must be very numerous, for in the southern coal-tract alone, the names of forty-nine seams, are enumerated. The respective thickness of 37 only of these are given; these amount, in the aggregate, to eighty-three feet, three inches.

It was in this region that the celebrated William Smith, the father of English Geology, first practically proved the correctness of his geological views as to the uniform order of superposition of the rock formations, and demonstrated the soundness of that magnificent system, which has been since adopted and accepted by men of science, over the entire globe. It was in this same region that the writer of this note, in 1811, became an admiring pupil of this extraordinary man and original genius.

Coal exported from Bristol to foreign parts, in 1844, 6,423 tons; in 1845, 6,976.

III. FOREST OF DEAN.

Messrs. Mushet, Buckland and Coneybeare, some years ago, described the general characters of this coal basin. Since then, Mr. Maclauchlan, Mr. Sopwith, and others, have made us yet better acquainted with the economic geology of this region.* The space occupied by coal-bearing strata is about fifty-six square miles, or near thirty-six thousand acres.

The productive coal area appears to occupy about 45 square miles. The authors of the "Outlines" state that it contains seventeen coal seams; which, together comprise thirty-seven feet, in thickness of clear coal. Mr. Mushet's

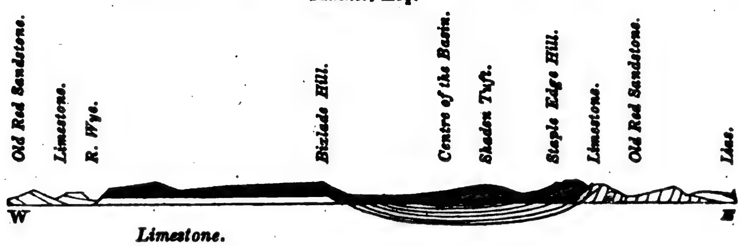
* Coneybeare and Phillips's Outlines, p. 428. Buckland and Coneybeare, Geol. Trans. Vol. I. p. 215. Maclauchlan in Trans. Geol. Soc. London, Vol. V.

vertical section, published in 1824, exhibits twenty-eight coal seams, whose aggregate thickness is fifty-two feet, one inch; the entire series of coal measures being 3060 feet.

A paper by Mr. Buddle, was read to the Geological Society, April 8th, 1840, "on the Great Fault, called the Horse, in the Forest of Dean coal-field." The details are not of a kind, however practically useful, essential to the purposes of this work.*

Fig. 19.

Section of the Basin of the Forest of Dean, between the Rivers Severn and Wye, by D. Mushet, Esq.



Mr. Sopwith has constructed a geological model of the Forest of Dean coal-field, which he has publicly exhibited. This is unquestionably, the most effective mode of developing the geological structure of any district. The horizontal scale of the model is five miles to the inch, but the vertical scale is three times as large. We are informed "this was necessary *to give a correct idea* of the country and the strata."† We should have thought such a distortion would be calculated to give an *erroneous* idea, rather than "a correct" one.

We observe a notice of a new map of the Forest coal-field and the neighbouring country, lately published, which promises to be a document of great local value.

IV. NEWENT OR NORTH GLOUCESTERSHIRE.

One of the smallest of the detached coal-fields; situated north of the Forest of Dean coal-field, in Gloucestershire. Mr. Maclauchlan (Geol. Trans., Vol. V. 203,) says the boundary is not easily defined. At least three workable seams, amounting to 13ft. 6in. occur in one shaft, of fifty yards.

This is a long narrow trough, containing about two and a half square miles, or 1600 acres. One of the beds of coal worked, is seven feet thick, but it is much distorted, and the coal contains a large quantity of sulphur. The same vein, it is supposed, was partially worked at another part of the coal-field; and here its quality was better, and it was less charged with sulphur. Mr. Murchison notes four thin seams of coal in the vicinity of the town of Newent, where the formation is most expanded. These were formerly worked, in some cases even beneath the new red sandstone.‡

* Ibid. Vol. III. p. 287.

† Mining Journal, Vol. X. p. 190, also Vol. XI. p. 355. Also Mr. Sopwith's paper on Geological Models, Inst. of civil Engineers.

‡ Proceedings Geol. Soc. London, Vol. II. p. 121.

V. BEWDLEY AND BILLINGSLEY, OR FOREST OF WYRE COAL-FIELD, IN THE N. PART OF WORCESTERSHIRE AND THE S. PART OF SHROPSHIRE.

The boundary, as exhibited upon the most authentic maps, contains an irregular coal area of sixty-seven square miles, or about 42,880 acres.

The details of this region were scarcely known to Messrs. Coneybeare and Phillips, at the time of the publication of their "Geology of England and Wales."

A paper was read to the Geological Society, February, 1834, by Mr. England, "on the Forest of Wyre Coal Field." The author is of opinion that the coal measures range uninterruptedly from Coalbrook-dale to the Abberley Hills. The greater part of the workings, at that time, were only shallow pits, which touched merely the sulphureous beds, locally called "Stinkers." A supposed peculiarity has been pointed out in the frequent recurrence of a subordinate calcareous conglomerate, forming a concretionary limestone. The coal-field is based upon old red sandstone, and contains intrusive rocks, like the other Shropshire coal basins. Mr. Murchison states that the greater part of the works on the different seams of coal, in this field, including all the deep shafts, are now abandoned, owing chiefly to the poor and pyritous quality of the coal. Sweet coal is of rare occurrence; though some thin beds occur at Lower Harcourt, near Kinlet. The sulphureous coals are little used, except for drying hops and burning lime. At Kinlet, the coal measures are perforated by a wide and extensive mass of basalt; in the neighbourhood of which the sandstones are, in part converted into a hard siliceous rock, called "White Jewstone." The author shows that the concretionary calcareous rocks, spoken of, are nothing more than protruding masses of *cornstone*, of the inferior old red sandstone.*

We may observe here, that these concretionary limestones, or cornstone, are equally common to the old red sandstone in the United States; and are not unfrequently burnt for the purpose of an ordinary grey lime, for building, in Pennsylvania.

VI. TITTERSTONE CLEE HILL, SOUTH SHROPSHIRE.

An area of about eight square miles, or 5120 acres, capped, near the centre, with basalt, occurs immediately west of the last described coal-field. This is one of the most considerable mountains in Shropshire. It contains the lowest members of the coal formation, and some beds of iron ore. These beds all dip towards the centre like the sides of a bowl.

The principal coal seam is six feet thick. Three other seams, of less importance, occur, and also cannel coal. Dr. Townson describes this area as made up of six distinct, smaller and perfect basins. It has been described in a memoir by Mr. R. Wright; also, in 1833, by Mr. Murchison, in a paper "on the sedimentary deposits of western Shropshire." The latter geologist furnishes some additional notices of the *Knowlbury field;* which, from its juxta-position to the larger field of Coalbrook, he terms a parasitic basin, and shows that it contains five seams of coal and some bands of ironstone. Considerable faults occur in this basin; which faults always occur as *upcasts* towards the higher sides of the hills, where the basaltic matter has found vent. The coal included between two of these upcasts, is described as

* Proc. Geol. Soc. Lon., Vol. II. p. 121.

much thickened, and in the state of cannel coal. Some beds of coal, according to recent investigations of Mr. Lewis, have been carried up on the top of the basalt, and the latter rock has flowed laterally, so as also to overlie the coal.* This small region has furnished many fossil plants, of new species, to Professor Lindley.

VII. BROWN CLEE HILL, SHROPSHIRE.

This remarkable mountain occurs at the distance of six miles north of Titterstone Clee Hill, last mentioned. It forms an elevated little coal-field, only two square miles, or 1280 acres in area. It is covered with a capping of basalt; the subjacent coal measures being arranged in the form of a flat basin or dish, and contains three coal seams, whose aggregate thickness is little more than three feet. In respect to quality, it is inferior to that of Titterstone Clee Hill.

Mr. Murchison says the coal bearing strata have for their base a hard sandstone, occasionally conglomeritic, the equivalent of the millstone grit. On three sides of this ridge, these very thin and poor coal measures repose on the old red sandstone. On the fourth is a thin zone of the mountain limestone.

A paper "on the Geology of the Brown Clee Hill," was communicated by Mr. R. Wright, to the Geological Society, in 1833. This coal-field is represented to have the form of the figure 8. It is traversed by a dyke of basalt; yet, the writer states, the coal is not in the least charred.‡

VIII. LICKEY HILL—WORCESTERSHIRE.

Two very small detached coal basins, occur here, near Bromsgrove, according to Dr. Buckland's notes, in 1819. These two patches of the coal formation are each about a mile in length, but have never yet been wrought on an extensive scale.

IX. WARWICKSHIRE COAL FIELD.

Forms an irregular trough, running N. N. E. twenty miles from Coventry to Tamworth, and averaging three miles in breadth; thus being sixty square miles, or 38400 acres, of exposed area. A section given by Mr. Yates, shows nine coal seams, amounting to thirty feet of coal.§

At Griff, four seams are worked; the principal one being nine feet in thickness.

At Bedworth, two of these beds, coming together, produce the five yard seam.||

X. ASHBY DE LA ZOUCH COAL BASINS IN LEICESTERSHIRE.

This area comprehends fifty-six square miles, or 35,840 acres, or according to other accounts, about 40,000 acres.

More than twenty coal works had been opened within this district, when Messrs. Coneybeare and Phillips described it, in 1822. They state that the deepest of these works is sunk 246 yards. One of the coal beds attains

* Proceedings Geol. Soc. Lon., Vol. I. p. 473.
‡ Mr. Wright in Proceed. Geol. Soc. Vol. II. p. 7.
§ Trans. Geol. Soc.—Vol. II.
|| Hist. of Fossil Fuel, p. 145.

the extraordinary thickness of from seventeen to twenty-one feet. In one of these pits, 572 feet deep, five principal seams are passed through, comprising thirty-three feet of workable coal. Mr. Bakewell published a transverse section of the Ashby Wold coal basin.*

Mr. Mammatt, who described the Ashby coal-field in 1836, and elaborately illustrated it by 114 plates, and representations of 200 specimens of vegetable fossils, states that the greatest depth then reached in this district, was 1,167 feet; passing 408 strata or coal measures; the main coal being about fourteen feet. From the extraordinary number of faults which intersect this coal-field, the mines are exempt from much inconvenience from water.†

The area is now calculated at near forty thousand acres, and the depth of the pits is mostly from three hundred to three hundred and sixty yards, while shafts and workings descend from 500 to upwards of 1100 feet, varying, at different points, according to the local depth of the basin.

The quantity of coal contained within this area, cannot be very exactly estimated; but if all the coal seams which exceed one foot in thickness were taken into account as workable, there would be sufficient for an annual yield, allowing for faults, of 150,000 tons [the present estimated consumption] for ten thousand years.

In common with others, Mr. Mammatt complains of the great waste of the small coal in this field; often amounting to one fourth of the whole seam.

The eastern part of this coal-field area is sometimes separately spoken of, as if distinct from the western. Several seams are worked; two of them being each a yard and a half thick: the sinkings not exceeding 116 feet.‡

The president of the Geological Society of London adverts in terms of commendation to Mr. Mammatt's work, which embodies the result of forty years' experience. Putting in practice the opinion adopted at an early period, that "strata are characterized by their fossils," the author has carefully registered the coal plants in each of the numerous beds in this region. But, as might be expected, we find many repetitions of the same genera and species, in distinct strata.§

Fire-Clay abounds, in seams, in the Ashby coal-field. "There are few coal seams which do not rest upon it, as is shown by the sections." One of these beds, four feet thick, lying immediately under a coal seam 3ft. 6in. thick, furnishes materials for an immense manufactury of yellow pottery ware; made at Ashby Wolds, to the amount of 10,300 dozens of pots per week. These are sent to all parts of Great Britain, the West Indies, America, &c., the latter country taking about one tenth.

XI. SOUTH STAFFORDSHIRE.—DUDLEY AND WOLVERHAMPTON COAL-FIELD.

This district was described by Mr. Keir in 1798, and subsequently by the Rev. James Yates;|| by Messrs. Coneybeare and Phillips in 1822; and among others, more recently, by Thomas Smith, in 1836; whose practical acquaintance with the details of this region entitles him to confidence. Later still, in 1843, it formed the subject of an elaborate report to Parliament, by the Midland mining commission.

* Bakewell—Third Edition—1828—Pl. 4, p. 2.
† Mammatt on the Ashby Coal Field, 4to, 1836.
‡ Coneybeare & Phillips—Geology, p. 404.
§ Anniversary Address—Feb. 20th, 1835.
|| Trans. Geol. Soc. London—Vol. II.

It was formerly described as occupying an area nearly twenty-two miles in length, and about seven miles in its greatest breadth. Assuming the dimensions on Mr. Greenhough's map as correct, we compute the contents at full 100 square miles, or 64,000 acres: and therefore, although Mr. T. Smith's estimate of 90 miles is corroborated by a third Mr. Smith, we prefer the latter calculation. Even then, we conceive that we underrate the accessible coal area; because the coal measures are evidently overlapped by a thick covering of new red sandstone, through which shafts have been sunk and have reached the coal. There can be no doubt but the coal producing formation will be found, ultimately, larger than the dimensions previously assigned to it. Mr. Murchison suggests also that this will probably be the case in other coal fields of the central parts of England.

This coal-field has, for convenient reference, been sometimes divided into two mineral districts.

The Southern area comprehends the larger portion, and also by far the thickest masses of coal; including, especially, the celebrated "ten yard coal" seam, one of the most important in Great Britain!

This coal is raised in quantities inconceivably great, and is used for the supply of the hundred iron furnaces which are placed in this district;—for the various operations of the forge, the foundry, and the numerous branches of manufacture which are thickly congregated in the neighborhood; and for domestic purposes. Much also is sent to a distance, in other counties. For the easy transit of these heavy materials, canals are constructed, which diverge from this focus of operation, and radiate in every direction. It is traversed also by railroads, which stretch to the remotest parts of England.

Towards the centre of this district the "ten yard coal" lies at the depth of 140 yards from the surface, decreasing in depth to the north: and showing that the whole mass of the coal measures inclines from the north to the south.*

The Northern portion of the Staffordshire coal-field extends from Walsall several miles northward; but, for the reason just stated, the outcropping of the strata in that direction, the beds are thinner, and of more limited extent; so that in the neighbourhood of Bilston, the thick coal itself comes to the surface, and is of course lost.

The Dudley coal-field supports a population of upwards of two hundred thousand individuals.

The operations in and around the coal mines are well described by W. H. Smith. That the productive coal measures extend beneath the overlying new red sandstone, to an indefinite extent, as we have suggested, there is recent proof in the success of the operations of the Earl of Dartmouth; who after sinking through the new red Sandstone, 151 yards, and thence, through the coal measures, to the final depth of 308 yards, reaching three coal seams, at Christchurch, one mile beyond the superficial boundary of the coal-field.†

Mr. Dunn, on the authority of Mr. B. Smith, shows that at West-Broomwich, the coal seams amount to 43ft. 8 inches, and at Wolverhampton to 67ft. 5 inches.‡

Near Dudley, the strata ascertained by the operations there carried on, and described by Dr. Thomson,§ amounted to nine hundred and forty feet. Of these, eighty-one feet consisted of coal, comprised in eleven seams of

* T. Smith's Miner's Guide.
† Proceedings Geol. Soc., Vol. II. p. 408.
‡ B. Smith—in Dunn, p. 138.
§ Dr. Thomson in Annals of Philosophy, Vol. 8.

various sizes, from nine inches to thirty-one and a half feet thick. This latter seam, the well known "main coal," is here one hundred and twenty yards beneath the surface. It is divided into thirteen different layers, separated by very thin partings of slate clay. Every one of these thirteen divisions has its name, designation, and peculiarity; so as to be selected for the uses to which it is particularly applicable. The middle series consists of the best quality, employed in private houses. The remaining part, amounting to about one half, is inferior, and is used only in the iron works. This coal does not cake. It makes an agreeable fire, burning to a white ash, and does not require to be stirrred.

Cannel coal occurs, to a limited extent, within this coal-field.

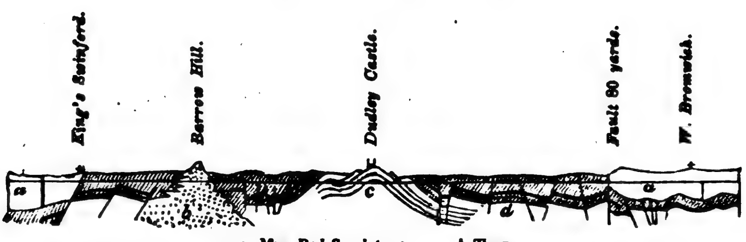
The area of ground, known as containing coal, according to authentic survey, when Coneybeare and Phillips described it, was sixty square miles. It is now found to extend over 100 square miles. This apparent discrepancy is explained by the opening of new ground, beyond the former limits,* induced by the increased value of, and demand for, coal, and the energy of mining proprietors. Of the immense amount of iron made and manufactured within this coal area, it would be scarcely relevant to speak: nor of the well known fire clay, which furnishes the celebrated Stourbridge fire bricks, is it our purpose to make other than this passing mention.

In Dr. Ure's Dictionary, fig. 803, is represented a diagram of the coal field at Dudley, forming an instance of *a convex coal-field*. The seeming inversion is regarded as resulting from the approximation of two coal basins, separated by the basset edges of their mountain limestone repository, but it is evidently nothing more than a concave basin, with a central synclinal axis. Fig. 804 of the same work, shows the vertical section of the Dudley coal basin. The 30 feet, or "*thick coal seam*," here seen, extends seven miles in length and four in breadth. Coal seams, five or six feet thick, are called "*thin coals*," in that district.†

The coal measures comprise 11 seams of coal, in all. A remarkable basaltic ridge runs obliquely through the coal-field, from north-west to south-east. This, and some other peculiarities of the Dudley coal-field, we have shown in the annexed diagram.

Fig. 19.

Section across the Dudley Coal-Field, in a N. E. direction.



a, a, New Red Sandstone. b Trap.
c Carbs. Limestone. d Thick Coal-Field.

Reduced from Pl. 3. First Report of the Midland Mining Commission:—originally from Murchison.

That portion of the South Staffordshire coal-field which may be denomi-

* W. H. Smith—Birmingham and its vicinity,—1836.
† Dr. Ure's Dictionary of Arts, &c., p. 967.

nated the Dudley Region, is detailed in the first Parliamentary Report of the "Midland Mining Commission" in 1843, previously referred to.*

The number of mines to each pit in Staffordshire is much less than on the Tyne.—

In ninety-two coal pits on the Tyne the number of workmen is - - - - - - -	12,833=139 to each pit.
In seventy " in South Staffordshire they amount to only - - - - -	1,926= 27 to each pit.

The remarkable difference in the condition of the mining population of the two coal regions is adverted to in the report. It is partly accounted for by the influence of capital in the northern district, and by the superior rank and wealth of the employers of mining labour there. "It is not unreasonable to imagine, *à priori*, that men of rank and capital will not condescend to adopt the shifts and expedients to which an inferior class of proprietors are, as it were, driven to resort. Besides, the former may be generally presumed to have enjoyed a better education, and also to be more amenable to public opinion. Hence, mining districts may be expected to vary in regard to the general and customary treatment of the workmen, according as the proprietors are, generally and on an average, of greater or less rank and wealth. This view is much confirmed by a comparison of the general customs with regard to the payment and the treatment of workmen, prevailing in South Staffordshire, and in the Northumberland and Durham coal-fields, respectively. In the former district, the immediate employers of labour, i. e., the lessees of royalties, and many of the owners of mineral property also, are men whose fathers, if not themselves, have risen to their present situation from the ranks;—speculators who have become wealthy *per saltum*, with the rapid progress of manufacturing prosperity.

On the other hand, the employers of mining labour on the Tyne and Wear, consist of the nobility and gentry and landed proprietors of those counties, as is the case also in Cornwall; the moral effects of which upon the mining population is proved to be strikingly beneficial, by the report of Seymour Tremenhere, Esq., inspector of public schools.

This difference in the general class of employers, in the two coal districts, results partly from natural causes, which render a much greater amount of capital necessary in the northern coal-field to overcome the physical obstructions by which the extraction of the mineral is rendered so difficult and expensive."†

The average depth of the workings in the northern and midland districts is not greatly dissimilar;

S. Staffordshire, 70 coal pits; deepest workings 260 yards; shallowest, 40 yards; average, 166 yards; 1926 workmen,—21,000.

Tyne and Wear, 193 coal pits; deepest shaft, 598 yards; shallowest, 42 yards; average yards, 170 Tyne; 150 Wear.

While in the first case the district is suffering under all the moral and physical disadvantages of the truck system, "tommy-shops and beer-shops," and the admission of contractors, ground bailiffs, butties,‡ doggies, and middle-men, there is a rooted dislike among all the proprietors of the

* Drawn up by Thos. Tancred, Esq. † Report, p. civ.

‡ *Butty* or *Gaffer*, the provincial name for contractors, who engage with the owner to deliver coal or ironstone, at so much the ton. They have generally been working miners, who, with the aid of their friends, are enabled to enter into a bond called a "charter," to raise coal for the proprietor or lessee; the pit's company being his hired labourers. The evils growing out of the system, are, according to the Report, very great. The butties, also, are not without complaints of the exactions of the owners, sometimes to the amount of three cwt. extra in each ton. Doggies are subordinate agents under the butties.

northern coal mines to any system of management which permits middlemen and contractors to oppress the workmen, and to prevent their enjoyment of the whole of their money wages. In the latter case, the men are paid at the end of each fortnight the full amount in hard money, for each ton of coal worked; the rate for which is agreed between themselves and the owners of the mine.

South Staffordshire.—The colliers are subdivided, in great measure, into two classes:—the thick coal and the thin coal miners. The working in the former, although commonly preferred, is attended by the greater danger. We have no very direct means of determining the comparative rates of accidents, owing to the want of registration. The author of the report of the Midland Mining Commission has partially arrived at the result in the following way—viz:

In an equal population, the average number of widows of killed miners, supported since the establishment of the Unions, is as follows:—

	per annum.
Widows of thick coal colliers, who had been killed in the mines, - - - - - - - - -	237
Widows of thin coal colliers, only - - - - -	168

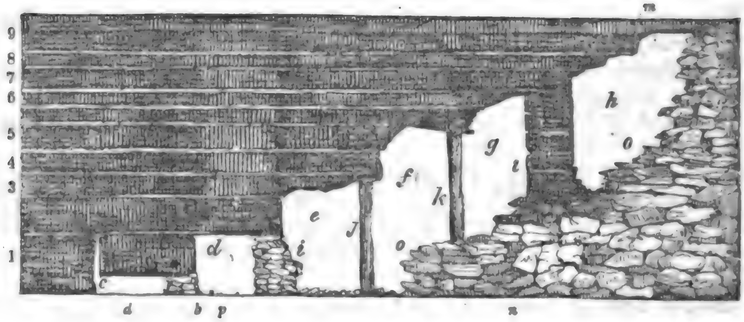
The test is nevertheless imperfect, becanse it does not include the widows who have not received parish relief, and do not appear on the books of the Unions.

In the thick coal pits, towards Dudley, the general depth to that coal is 210 or 220 yards. At Lewisham 135 yards, a colliery of Lord Dartmouth, 212 yards; and the Heath colliery, cut through the new red sandstone, 308 yards.

Mode of working the Main or Ten Yard Coal of Staffordshire.—The entire bed consists of a series of thirteen seams of coal, each having separate names, of different or unequal thickness, amounting to 28½ feet, with the aggregate thickness of slate partings, 18 inches more; in all thirty feet from roof to floor. These are worked down by a series of six or more successive falls and undermining of the coal seams, after the manner shown in the subjoined diagram.

Fig. 20.

Section of the working of the Main or Ten Yard Coal, in the Dudley Coal-Field.



It is unnecessary to detail here the names and thickness of the several beds. The work commences by cutting out the lowest bed, called the Humphries, to ten or fourteen yards, the width of the *stall*, and two feet three

inches high, which is the usual thickness required by the miners for *holing*, or undermining. The foundation of the coal being thus far removed, to a certain breadth, they then *cross cut* it at right angles, vertically, to loosen its adherence to the sides; cutting up as high as the third parting of slate. This, when separated, makes the first *fall* of coal, having a thickness of six feet three inches. The labourers who perform this part of the work, are locally called *holers* or *pikemen*. They undermine or cut out the coal with light picks, building up small supports, called "*cogs*" from the slatey *spoil* heaps, called "*gob.*" The vertical cutting is always carried up until it reaches a parting; but it does not appear that any exclusive selection of these partings is made. At these slate partings the coal readily separates, and falls down when the supporting cogs are removed. The same process is adopted with regard to the second fall, and a succession of cogs and wooden props temporarily support each series of falls, for the security of the holers. It is also common to leave a pillar of coal, called the *man of war*, to support the upper benches of coal until the lower are worked; it is then taken away, and the upper coal falls down. A small portion of the coal seam at the upper part of each cutting, is left as a temporary support against the main body: this portion is called a *spurn*.

1. The lower fall of coal consisting of large seams.

2. The second fall consisting of a small seam.

Other falls in succession.

a, The first holeing or undermining in the Humphries bed, two or three inches clear.

b, Lower cog, to support the first mass.

c, Vertical narrow cutting, to separate this coal from the main mass.

d, Opening for the second fall.

e, f, g, h, Openings for successive falls, each requiring more elevated scaffolds.

i, Second cog, preparatory to the second fall.

j, k, Wooden props, for similar purposes. These are removed when the other work is completed, by experienced colliers, armed with long prickers, to tear away the cogs, spurn, props, and pillars.

l, The temporary pillar of coal, called the man of war, subsequently taken away.

m, The stony measures forming the roof of the coal.

n, The slatey floor of the coal.

o, o, The spoil, or broken measures, which fall down as the coal is got out.

p, A railroad, which is carried forward as the work advances.

We are reminded, in the system of working here adopted, of that in established use in the thick bed of thirty-nine feet, at the coal mine of Blanzy, in France.

	Tons.
In 1837, the quantity of coal supplied to Birmingham by the canal was - - - - - - - -	367,800
" the quantity of coal furnished to the works in the mining district, - - - - - - -	772,167
" the quantity of coal supplied to other canals, - -	451,628
South Staffordshire district,	1,591,595

Conveyed on the old Birmingham canal.—The Staffordshire district being divided by a range of hills, there are two other ca-

nals upon which coals are loaded, namely, the Dudley and the Stourbridge canals. The quantity of coal thus conveyed was about, - - - - - - - - - - 500,000

Aggregate of coals conveyed by canals, in this district only, in 1837,* - - - - - - - - - 2,091,595

At that time the Staffordshire coal found a market as far south as Oxford, and there met the north country coals which westward passed through the port of London.

The Staffordshire coals are of the quality called *White ash Coals*, very few of which reach the city of London, and the quantity has even diminished since 1832, as the abundance of white ashes is objectionable to those who are accustomed to use, in their grates, the caking or fat bituminous coals of the north.

If there were a greater demand, or a wider market for the Staffordshire coal, many more mines could be opened; for there is an abundant population to work them. The greater portion of coal appears now to be absorbed by the iron works of the neighbourhood; the number and capacity of which, and the progressive increase in the manufacture of iron, owing to the substitution of mineral coal for fuel instead of charcoal, will be seen in the following table.

The quantity of iron made within the Staffordshire district.†

	1740.	1796	1806.	1823.	1830.	1839.	1841.	1842.	1846.
Number of Furnaces in and out of blast,	9	14	42	84	123	118	135	129	146
Make of iron annually,	2,550	13,210	49,460	133,590	212,604	367.330	347,152	346,840	500,760

At the Blakemoor iron-stone pit at Corngreaves, near Dudley, belonging to the British Iron Company, the ore is fourteen yards below the thirty feet, or thick coal seam; the one being 180 yards from the surface, the other 194 yards deep. The steam-engine draws coal alternately with the iron-stone, from the same pit. This iron-stone is only a thin band of some five or six inches thick, in some places divided into two. There are sixty acres of ore commanded by this pit.

For details of the mode of working out the thick coal seam, above, the reader is referred to the report of the Midland Mining Commission, 1843, and to some of the other authorities to which we have adverted.

The grievances complained of by the miners, which occasioned their general strike, in 1842, were investigated by this commission. The evils of the system appear to be fairly stated, in their report. Among these, the "truck system," is conspicuous, and the surprising prevalence of beer shops. It will scarcely be credited that in the twelve parishes of the Dudley coal district, according to authentic lists of the supervisors of excise, there existed the following numbers:

Number of victuallers, - -	574
Number of licensed beer shops, -	723
In all,	1297

* Minutes of evidence on the Coal Trade Bill of London, 1838, p. 140.
† Midland Mining Commission, 1843, First Report, and subsequent sources.

This report, being directed chiefly to the moral and social condition of the mining population, affords no information of the quantity of coal mined, or the prices at the mines or in the district.

XII. COALBROOK-DALE, SHROPSHIRE.

This coal-field, according to the geological investigations of Mr. Prestwich, contains thirty-two square miles, or 20,480 acres.

The average thickness of the principal workable coal beds is about three feet; and the number of the seams varies from thirteen to twenty-four; seventeen being, probably, the average. They occupy, for the most part, a horizontal position, but are intersected by numerous faults.

The coals of this district are generally of the variety called *Slate Coal.* Of course there are certain differences in the quality of each vein. Details of the component parts of the principal coal seams have been furnished by Mr. Prestwich, an approximate statement of which will suffice to show the character of the Shropshire coal.

Volatile substances in 100 parts,	34 to 41
Carbon, - - - - -	56 to 64
Ashes, - - - - -	0.9 to 2.8

There are several seams of argillaceous iron ore interstratified with these coals, producing upwards of three tons per square yard.

The average produce per acre of this area, is stated by Mr. Smith, as follows:

Large coals, - - - - -	31,944 tons per acre.
Small coal, or slack, - - -	7,986 "
Iron-stone, - - - - -	13,794 "

The average specific gravity of the coal is 1.268
" " of the iron ore, 3.527

Coalbrook, or Colebrook, Dale has been long celebrated for its iron works, which once produced the best iron in England,* and was the first establishment in England [1713] where iron was made with pit coal.† Mr. Coneybeare states that the coal measures dip to the E. S. E., at an angle of about six degrees.

In the Madely colliery a shaft has been sunk 729 feet, and exhibits twenty seams of coal; varying from four inches to five feet thick, of several varieties, and comprising twenty-six feet in the aggregate.‡

There is, perhaps, no coal-field in England, of equal size, in which the strata have been so much dislocated. Sometimes these faults or dislocations amount to 600 or 700 feet. Mr. Prestwich observes, that this coal-field must once have been entirely concealed under a covering of new red sandstone.

This coal-field, according to Mr. Murchison, rests on a thin band of the mountain limestone, in part, and partly on transition rocks.§

Mr. Prestwich furnishes details of all the faults in this coal-field. There are four principal and many minor faults: one of the former is 260 yards vertical.||

* Transactions of the Geological Society of London, Vol. V. p. 413.
† Midland Mining Commission, 1843.
‡ Coneybeare and Phillips, 421.
§ On the Sedimentary Deposits of Western Shropshire, &c. R. J. M., 1833.
|| Proceedings of the Geological Society of London, Vol. II. p. 19.

The aggregate thickness of coal varies from thirty-three to forty-five feet. A bed of freshwater limestone occurs in the upper part of the measures, one to two yards thick. Carburetted hydrogen is disengaged in greater abundance from the upper than the lower coal measures; and in greatest quantity on commencing a new work; especially on approaching a fault when *large masses of coal are constantly blown off* the main beds, with loud reports. Carbonic acid gas is rarely found in a pit at work.*

Few situations, we are told, could be more favourable for the establishment of iron-works than Coalbrook-dale. The iron-stone is interstratified with the coal, and the subjacent mountain limestone is an admirable flux for the reduction of the metal. Here was laid down the first railroad for coal wagons that ever was known in England.

In the foundries alone, as moulders, finishers, fitters, &c., there are 600 men employed; in the works of the company altogether, including colliery, employment is given to between 3000 and 4000 men and boys. Coals are supplied to the operatives at seven shillings, $1.68, per ton, and this cheapness of fuel greatly contributes to the comforts of their households.

The Coalbrook-dale works are the first of the empire in the artistic excellence of their productions, and the conductors are exerting themselves to maintain this superiority by sparing no expense in procuring the best models, at home and abroad.†

XIII. A. SHREWSBURY COAL-FIELD, SHROPSHIRE.

An irregular area with some detached patches of coal measures, altogether comprising twenty-five square miles, equal to 16,000 acres. This assigned area is, probably, under-estimated.

The carboniferous beds here repose on the inclined edges of the Silurian rocks, and dip to a common centre beneath the new red sandstone. Three thin beds of coal are, for the most part, observable. This basin is distinguished by an included band of limestone, similar in mineral aspect to the lacustrine limestones of Central France, and containing minute shells referrible to *fresh-water* genera. The vegetable remains of the associated shales are chiefly analogous to the plants of other coal-fields. Mr. Murchison, after demonstrating the slight commercial value which can be attached to the thin deposits of this age, speculates on the probable importance of the outer zone or Pontesburg field, which he presumes may expand to a greater thickness, in its passage beneath the new red sandstone of North Shropshire and Cheshire.‡ In a subsequent communication, the author establishes "the existence of a younger zone of coal, which contains a peculiar fresh-water limestone, and which passes upward into the oldest strata of the new red sandstone, in Shrewsbury coal-field, and downwards into the inferior coal strata of Coalbrook-dale."§

XIII. B. OSWESTRY COAL-FIELD, SHROPSHIRE.

We had proposed to class this with the Cheshire and Flintstone Coal-field, No. XXXIX.; but as it really is detached from that, it comes more properly under our notice here. It is of small extent, and little pro-

* Proceedings Geological Society of London, Vol. II. p. 403.
† London Art Union, 1847.
‡ Proceedings Geological Society of London, Vol. I. p. 472.
§ Ibid. Vol. II. p. 119; also p. 122.

ductive; containing only one bed of good coal. Faults are numerous, and in the principal one, the coal is upcast 180 yards. Like the great coal basin of South Wales, this has been deposited upon a thick girdle of carboniferous limestone.

XIV. NORTH STAFFORDSHIRE OR POTTERY COAL-FIELD.

Properly speaking, there are two separate sections or coal-fields included in this name.

The first, or *Newcastle under-line* area, contains, according to Mr. Greenough's Geological Map, sixty-three square miles, or 40,320 acres.

At Burslem, in the centre of this field, from thirty to forty beds of coal occur, which, in general, vary from about three to ten feet.

At Apendale, Newcastle under-line, the coal works are carried on to a great depth under the surface;* but the height of the ground above the level of the sea, is not accurately ascertained or specified.†

The coal measures here repose upon the silurian rocks, the old red sandstone and the mountain limestone being absent.

In this coal-field Sir P. Egerton found, among other remains of fishes, some scales of the megalichthys, a large sauroidal fish, first described by Dr. Hibbert, as occurring at Burdiehouse, near Edinburgh.

Pig iron made in North Staffordshire:

	Furnaces in and out of blast.	Tons annually.
1843		32,240
1846	21	79,560

XV. THE SECOND OR CHEADLE AREA.

Lying two miles east of the preceding, contains only fifteen square miles, or 9600 acres, surrounded by an extensive area of millstone grit, in which some coal pits are sunk.‡

XVI. DERBYSHIRE.

Two coal patches or out-liers, east of the foregoing, and between it and Derby.

1st. *On Darley Moor.*—About a square mile.

XVII. 2d. *On Shirley Moor.*—Also about one mile square, at Sprinxhall.

XVIII. LANCASHIRE AND CHESHIRE OR MANCHESTER GREAT COAL-FIELD.

This is so irregular in form as to require some care in ascertaining its dimensions. It is near fifty miles long, in two directions, with a maximum breadth of fifteen miles; stretching from near Liverpool in a north-east direction into Yorkshire, and from thence due south, passing Manchester, to below Macclesfield; being an area of from five hundred and fifty to six hundred square miles, = from 350,000 to 384,000 acres; the latter is more probably the correct amount. This comprehends the productive coal seams only. Were we to include the lower members, of which the millstone grit is the principal, and in which are many coal pits at intervals along a range of seventy and more miles; it would enlarge the above mentioned area to more than a thousand square miles.

* Smith, Miner's Guide, 1836, p. 160.
† Cosmos, Note 94, Humboldt.
‡ Farey's Derbyshire, p. 173.

Mr. James Henwood, in a paper read to the British Association in 1837, on the coal-fields of Lancashire, assumes their dimensions at four hundred square miles; meaning, we presume, strictly the area within the county of Lancashire, in which area, he states, there is still an unexhausted supply of coal for eighteen hundred years, at the present rate of demand.

To furnish some idea of the probable extent of such a demand, he adds, that in 1836 the quantity received in Manchester alone was nearly a million of tons, the value of which was about half a million of pounds sterling.

In so extended a region, it would require more space and details than our plan permits, to describe it to any effectual purpose. We must select only a few characteristic notices, although so valuable a field deserves far better at our hands.

The authors generally consulted are Messrs. Farey, Coneybeare, Phillips, Bakewell, Binney, Henwood, Dunn, &c.

The Wigan Coal burns quicker than the Whitehaven coal, and cakes less. Caking coal gives out a strong quantity of heat, and, with attention, burns a long time. Consequently, where it can be procured at a reasonable price, it is commonly preferred.*

At the meeting of the British Association in 1842, Mr. E. W. Binney furnished a paper on this coal-field. The author divides the series of coal measures into three groups, in descending order. I. The Manchester coal field. II. The Middle field, containing the thickest seams. III. The Lower coal seams, of no great thickness.

The sections of this region are unequal, as regards the aggregate of strata and of coal seams. In one direction, the thickness of the formation is two thousand yards. In this are comprised *seventy-five* beds of coal exceeding one foot in thickness, and having an aggregate of *one hundred and fifty feet* of coal. (Eighty-five coal seams according to Mr. Phillips.) Traversing another direction, a second section developes thirty-six coal seams, ten of which are less than one foot in thickness, and amount to ninety-three feet of coal.

Quality of the coal.—The author describes two varieties—the *cubical*, where the cross cleavage runs at right angles to the main cleavage; and the *rhomboidal*, where it makes an acute angle. *Cannel coal* is in the lower part of the middle division of the Lancashire coal-field, and nearly always contains remains of fishes and shells, and but seldom any vegetable remains. The upper portion of the coal seams generally abounds in the latter.† Mr. Williamson, also, describes fossil fishes as occurring in the slate roofs of the Lancashire coal seams.

It has been calculated that the available coal beds of Lancashire amount in weight to the enormous sum of eight thousand four hundred millions, = 8,400,000,000 of tons. The annual consumption of the coal is ascertained to be 3,400,120 tons. Hence it is inferred that the coal-field of Lancashire, at the present rate of supply, will last 2470 years.

It is estimated that two thousand persons are employed in supplying Manchester alone with coal.

Coal brought into Manchester	in 1834	737,000 tons
	in 1836	913,991 tons
	in 1840	1,034,090 tons

* Tredgold.

† Communications to the Manchester Geological Society in 1841, and to the British Association in 1842.

The Victoria pit at Dukinfield, to the level of the cannel or two feet mine coal, is one thousand feet deep. This vein or seam consists of sixteen inches of good cannel, and ten inches of common coal. The bed of fire clay on which it rests, contains the long stringy fibrils, so characteristic of stigmaria, and has furnished an interesting specimen, which shows that the sigillariæ and stigmaria are different portions of the same plant or tree.*

A seam of coal six feet thick has been struck at Patricoft, on the land of I. T. Trafford, Esq., at the extraordinary depth of 1350 feet below the surface. The shaft was three years in progress. But the deepest shaft in this region, according to Mr. Dunn, is 507 yards or 1521 feet, at Pendleton, near Manchester. That of Sankey brook, near St. Helen's, is 459 yards, = 1377 feet.

Mr. Dunn, who is the most recent authority we have seen concerning this district, remarks that "the limit of this extensive coal-field is not yet defined, nor can the immense number and variety of the different coal beds be specified."

I am of opinion that a great district of country to the westward of Prescott remains as yet unproved, and which will be found to contain coal. The ordinary bituminous coal prevails over the whole district; but the neighbourhood around Wigan seems to possess the most valuable descriptions in the cannel and the orell coals:—the former remarkable for its production of gas, the latter for house purposes, being of a quality very similar and little inferior to the Newcastle coal. As a proof of the estimation in which the orell coal is held, a property of thirty statute acres in that neighbourhood, consisting of nine feet of coal, in three seams, was sold, in the year 1825, for the enormous sum of £24,000, [$116,160, = $3872 per acre.]

The cannel coal is of a peculiar formation. It is often closely connected with, and often far apart from the king coal beneath. Its fracture is smooth, jet-like; it abounds with gas, and takes a fine polish. In short, it is like no other coal, nor do I believe that the like of it is found in any other coal-field in Britain.

Generally speaking, the Lancashire coal-field, abounding as it does with such a numerous succession of seams, presents very few of the mining difficulties which attach to the Newcastle district. The sinkings are moderately deep; the quantity of water inconsiderable; and the seams lie at convenient angles, and of eligible thickness for economical working.

An opinion seems to prevail, that the [new] red sandstone which extends from this neighbourhood to Liverpool, and across Cheshire, is indicative of a deficiency of coal. But it does not appear that any trials have been made to such an extent as to ascertain the fact; and it is a matter of curious speculation, whether there be any well grounded assurance against coal existing underneath the Liverpool red sandstone. I confess, it does not appear to me that there is; and I think that deep borings will hereafter prove a continuation between the Lancashire and the North Wales seams."†

Collieries about Oldham.—From the Royton mines are conveyed [1846] four hundred and ten tons per day, from a seam three feet six inches thick, producing one ton per yard, and working out half an acre per week. The most valuable mines in this district are the Copperas house, the Chamber, and the Warmley-wood, which produce six thousand tons weekly. From the Warmley-wood colliery alone, 150,000 to 170,000 tons are sent to Manchester yearly.

* Quarterly Journal of the Geol. Soc. of London, Vol. II. p. 390.
† Dunn, History of the Coal Trade, 1844, p. 129.

Prices of the best Coals at Liverpool.—1839. Orell, 14*s.* 6*d.*, = $3.51 per ton. River, 11*s.*, = $2.66 per ton. Cannell, 20*s.*, = $4.84 per ton.

Quantity of coal exported from Liverpool.

Years.	Tons.	Years.	Tons.
1833	50,561	1838	95,648
1834	59,078	1839	103,630
1835	61,542	1840	109,546
1836	90,024	1841	119,949
1837	95,188		

As the bulk of the coal, chiefly orell, which leaves the port of Liverpool is produced from the Lancashire coal-field, we add the following table of the destination of coals from that port in the year 1842, which will give some view of the distribution:

Total Shipments to Foreign Parts.

Years.	Tons.	Destination.	Approximate value on board.
1833	50,561	United States,	£12,500
1834	59,078	East Indies, (English,)	7,500
1835	61,542	West Indies,	6,200
1836	90,024	Brazil,	6,300
1837	95,188	Canadas,	5,100
1838	95,648	Spain,	4,200
1839	103,630	Prussia,	3,600
1840	109,546	Portugal,	3,500
1841	119,949	East Indies, (Foreign,)	2,500
1842	111,275	Turkey,	2,300
1844	75,479	Not enumerated,	9,750
1845	123,456		
			£63,450

The specific gravity of the South Lancashire coal, near Bolton, is 1.331. That of the Lancashire cannel coal, only 1.199.

The coal used at the salt-works at Northwich, Winsford, and other places, is obtained from the collieries in the southern part of Lancashire, near St. Helen's. The flat-bottomed boats which convey the sált from the different works to Liverpool, after discharging their cargoes return loaded with coal; so that few channels of communication are more crowded than the Weaver. No less than 400,000 tons of white salt are annually sent from this region only, employing a capital of £700,000,=$3,388,000.

The transportation of coals on the Liverpool and Manchester railroad, [opened at the close of 1830,] has annually increased, so far as the returns which have reached us extend.

	Years.	Tons.	Years.	Tons.
First year,	1831,	11,285	1835,	116,246
	1832,	69,396	1836,	138,893
	1833,	81,509	1837,	150,000
	1834,	99,337		

XIX. KIRKBY LONSDALE OR INGLETON COAL-FIELD.

A small coal-field in Yorkshire, containing about four square miles, or 2,560 acres. Partly described by Professor Phillips, in 1836.* It is situated in the low valley of the Greta, on the foot of Ingleborough. It is not properly a basin, for the planes of stratification have scarcely any other dip than to the north-east, and is remarkable as being on the border of a great fault or dislocation of the strata, amounting to about three thousand feet.

Mr. Hodgson's section exhibits two coal seams of two feet each, one of four feet, one of nine feet, and three small seams, within the depth of 224 feet. The new red sandstone and red marle cover this coal-field. Some of this coal is of the nature of cannel coal.

In three varieties of the Ingleton coal the specific gravity varies only from 1.195 to 1.310.

At the bottom of the mill-stone grit, on which this coal rests, are two thin beds of coal. This coal, being more earthy and pyritous, is heavier than the foregoing, the specific gravity of six results by Professor Phillips, being 1.500.

XX. GREAT CENTRAL COAL-FIELD OF SOUTH YORKSHIRE, NOTTINGHAM, AND DERBYSHIRE.

This is one of the largest of the English coal-fields, extending from Leeds, by Sheffield, to Nottingham; being sixty-seven miles long, and averaging above sixteen miles broad, making one thousand and ten square miles, or 646,400 acres.†

At the time Mr. Farey described this truly important region, in 1811, there were five hundred collieries in work. The principal seams, worked chiefly for the supply of Sheffield, are six in number, with about twenty-six feet of coal, besides six other workable beds. In this field one of the most valuable seams produces the variety called cannel coal, which is peculiarly adapted for making gas, for burning in grates, and also used by the Birmingham turners, for toys and ornaments.

Professor Phillips, in 1832, communicated to the British Association, a memoir on the lower coal series of this district.

At Alfreton works, in Derbyshire, according to Mr. Bakewell, there are thirty beds of coal, of the aggregate thickness of seventy-eight feet. There are many fine seams within this field, spoken of by other authorities.‡

It was estimated, a few years ago, that the manufacturing town of Sheffield alone, consumed 500,000 tons of coal annually, derived from the collieries adjacent. Almost every variety of coal appears to occur in this field. Amongst these are—

1. *Hard stone coals, anthracites*—Which neither flame, nor coke, nor run together.

2. *Soft or crozzling coals*—Which do both; but the same bed often changes from one quality to the other.

3. *Cannel coal, and Peacock or Iridiscent coal.*

On the north-western part of this coal-field, around Halifax, the coal is described as very indifferent, and only suited to engine fires. Such as is not used for that purpose is converted, in brick ovens, into coke, locally

* Phillips's Yorkshire, Part 2, 125, p. 130. † Geological Society's Map, 2d edition.
‡ See Alpha in Mining Journal, 1837, p. 172.

called *cinders*. These cinders are sold to maltsters, and for the use of locomotive engines. The coal veins are quite thin, and contain much sulphur. Their specific gravity ranges between 1.200 and 1.480.*

Near Bradford, only two workable seams, according to Mr. Dunn, are known. These are thin, but the coals are of prime quality for making coke, and the strata abound in layers of excellent iron-stone.

A communication, respecting the northern part of this Yorkshire coal-field, has been made, by Mr. Embleton, to the Geological and Polytechnic Society of the West Riding of Yorkshire. This illustration was limited to nine townships. The workable seams in these townships are described as ten in number, and are particularly detailed in the paper. These seams are comprised within a thickness of 552 yards of coal measures.†

Near Leeds, at Newton colliery, seven seams are worked, comprising near 18 feet of coal.

The deepest colliery in Yorkshire is 290 yards, at a shaft near Wakefield, recently completed. This shaft is fitted up with slides and tubs, according to the recent improvements of the Newcastle district. Other pits are fitted up with endless chains.‡

At Barnsley an explosion, from fire-damp, occurred in November, 1841, when fifteen persons in the coal pit were killed.

Through the facilities afforded by the Midland Counties' railway, coals were sold at Scarborough, in 1846, at as low a price as 7*s*. 6*d*. per ton.

Yorkshire coals imported into London from the Humber, by sea.			Exported to Foreign Parts from Hull.			
	Years.	Tons.	Years.	Tons.	Years.	Tons.
aver. of 4 years,	1828 to 1831	25,134	1833	7,463	1839	28,426
aver. of 4 years,	1832 to 1835	28,186	1834	12,161	1840	29,344
	1836	21,189	1835	10,078	1841	37,849
	1837	16,106	1836	15,642	1844	45,400
	1840	60,069	1837	6,225	1845	42,789
			1838	14,510		

Near Chesterfield, in Derbyshire, the pits are from 300 to 500 feet deep, from which coals are now being sent along the railroads to London.

XXI. MILL-STONE GRIT COAL SERIES.

Grit and Shale and Lower Coal of Yorkshire.—Extending northward, through Yorkshire to Durham, is a great region of mill-stone grit and shale, which was originally included by Dr. William Smith, in the main coal region. This portion embraces seven hundred and fifty square miles; to which we might add two hundred and fifty more, lying westerly, in Lancashire. In all this great range are thin seams of coal, more or less worked, at scattered points. On the whole, they can scarcely be considered of importance, while so much coal is attainable in the surrounding districts.

According to Professor J. Phillips, the Yorkshire mill-stone grit furnishes coal seams throughout that country, and gives employment to numerous collieries. Upon the recent geological maps, however, this large area is not designated as a coal region, but as the mill-stone grit formation. Dr. Wm.

* On the collieries around Halifax, by J. S. Hiley, Mining Journal, Vol. XI. 342, 353.
† Mining Review, 187.
‡ Dunns' History of the coal trade, p. 128.

Smith's original geological maps represented the whole area, from the grit, inclusive, to the regular coal measures, as one great and entire coal-field. It thus comprised one connected coal region, from Nottingham to Berwick, a distance of two hundred miles; and which, according to the late arrangement, is now subdivided by the interposing lower group of mill-stone and shale with thin coal seams, into four or five distinct coal basins, to the exclusion of the latter.

XXII. WESTMORELAND, NEAR APPLEBY.

Three Coal-fields.—Three detached coal basins, to the west of Appleby, have several working-pits sunk in the lower shale, within their respective areas. Properly speaking, these do not belong to the main coal formation. The three little districts comprise together about twenty-six square miles, or 16,640 acres.

Sebergham, Cumberland, coal basin.—A peculiar seam of coal is worked at this place, near Heskett. Its fracture, according to Mr. Dunn, assumes a "diamond form." It partakes partly of the nature of Parrot, caking coal, and anthracite, and is of rare quality. The basin is very small, and apparently unconnected with any of the neighbouring coal-fields. The seam is nearly three feet in thickness, twenty-two fathoms in depth from the surface, the water from which is pumped by means of a water-wheel, worked by the neighbouring rivulet.*

Aketon, Cumberland, coal basin.—A detached coal area or outlier occurs to the north of Wigton, and of the Whitehaven coal-field. It contains four square miles, or 2560 acres.

XXIII. WHITEHAVEN COAL FIELD, IN CUMBERLAND,

Stretches in a remarkable crescent form, along the eastern shore of the Irish Sea, forming a curve forty miles in length, and full three miles in average breadth,=120 square miles, or 76,800 acres, according to Mr. Greenough's map, of 1839, without including the submarine portion.

Seven beds have been worked at Howgill, west of Whitehaven, the mines being carried more than a thousand yards under the sea, and about six hundred feet below its bottom. In this vicinity a shaft has been sunk nine hundred and ninety feet, passing through seven workable, and eighteen thin, coal seams: the former amounting to upwards of thirty-five feet of coal. At Preston How, after passing through fourteen thin coal seams, the fifteenth proved more than five feet in thickness, and the seventeenth was nearly eight feet.†

With regard to its mode of burning, we are informed that the Whitehaven coal burns at first with a clear flame, and for a long time, but at last cakes.

According to Professor Sedgewick, the rich coal-field of Whitehaven, is separable, vertically, into two divisions: the upper containing the *Great main* and *Bannock-bands*; the lower containing four or five workable beds, but of inferior quality. The united thickness of these two divisions of coal measures is perhaps, not less than 2000 feet. The professor describes a fault on the west side of this coal-field; producing a downcast to the south-west, of not less than a thousand feet. West of this, the coal seams crop out in that direction; so that all those which are below the high water

* Dunn, p. 133. † History of Fossil Fuel, p. 146—and Coneybeare, p. 385.

mark, necessarily crop out under the sea. The result is that no one has been able to extract the coal from this space, in consequence of the great quantity of sea water, which finds its way through the beds along their planes of dip. South of this, the dip of the whole series is reversed; and here the coal beds have their out crops in the interior of the country, while at the sea board they are perfectly protected from the sea by the impervious overlying beds of shale. Such is the position of the submarine portion of the coal-field of Whitehaven; and it does not seem possible to assign any limit to the works that may there be conducted under the sea, in the direction of the dip.*

In his recent work on the coal-fields, Mr. Dunn states, that an extensive "winning" is now [1844] in progress at Whitehaven, intended to be the deepest sinking and most extensive drifting, in the kingdom, in order to prosecute the working of this ocean coal. The conveyance of coals along the intended horizontal stone drift is to be accomplished by engine power; either stationary or locomotive; and the seams to be won are the main band, 10 feet, and the Bannock band, 7 feet thick. The same seams prevail at Workington; but since the catastrophe in 1837, all working under the sea has ceased; and can only be restored by an exceedingly deep sinking, and most extensive drifting.†

Prices.—Price of Whitehaven coal in 1839, at the port, 7*s*. 6*d*. per ton,= $1.81.

From various causes, the trade in Whitehaven coal declined, and in 1840, it was complained, that *Dublin was the only market*, and the prices obtained were scarcely sufficient to protect the ship owners from loss. In 1842, the prices were so reduced that these coals only obtained 13*s*.=$3.13 per ton, in Dublin; entailing an absolute loss upon the shippers.

In 1841, the exports of coal coastwise from Whitehaven, chiefly to Dublin, the Isle of Man, and the south of Scotland, amounted to 451,370 tons, and those to foreign parts to 23,478 tons.‡

Since the completion of the Maryport railway, great quantities of coal have been opened in that neighbourhood, for exportation, and now form a powerful competition with Whitehaven and the rest of the western coast. The following table shows the decrease of shipments from this port:

Shipments of coal from Whitehaven to foreign parts, in 1841—23,478; in 1844—12,734; in 1845—1,084.

XXIV. COAL OF THE MOORLANDS OF YORKSHIRE.

Inferior Oolite Coal of Whitby.—This inferior coal is adverted to here, for geological reasons, although scarcely deserving a place in our list of the English fields. Mr. Winch§ points out its geological relations to the Yorkshire Oolite. Although the seam is only from twelve to seventeen inches in thickness, and the quality is very inferior to the true coal, yet it is occasionally worked for ordinary purposes in the neighborhood. This thin coal formation overlies the lias or alum shale of Whitby.

According to the geological map of this district, published in 1828, by the Rev'd George Young, this oolite coal formation extends about forty

* Sedgewick on Geol. Trans. of London, Vol. IV. part 2—Second Series, 1836.—Also Proceedings, Vol. II. p. 419.

† Dunn—History of the Coal Trade, p. 132-133.

‡ McCulloch's Gazetteer.

§ Trans. Geol. Soc. London—1821.

miles in length, and about four miles in breadth. That author states that the coal is very variable in character, there being sometimes numerous thin seams; at others, a single seam, or none at all. In quality, this coal is equally variable; sometimes slaty, while other parts are of an excellent quality, breaking like the best coal, into cubical fragments, with smooth shining surfaces. With these irregularities, it is scarcely to be expected that the coal of this geological age and position, should repay the cost of working extensively. The seams appear to be thinnest next to the seacoast. In the interior the coal seams are more considerable, and have been worked for a hundred and twenty years. At the Danby pits, the quantity of coal obtained here, at the time of Mr. Young's survey, was 200 or 300 bushels per day, on an average. Several other collieries are in operation.

This coal-field is traversed, for several miles, by a basaltic dyke, which has reduced the adjacent coal to a cinder, and sublimed the sulphur from the pyrites. The coal shale, when in contact with the trap, was found by Professor Sedgewick, to be so indurated, as to resemble Lydian stone, and the limestone was converted into a granular mass; retaining no traces of its organic remains.

While on the subject of this oolitic coal formation, we might advert to some sensible observations of Mr. Burr:* He remarks, that of the numerous unsuccessful attempts to obtain coal, in England, by far the greater number have been in rocks belonging to the oolite formation. Many of the clayey beds of the oolite, and more especially the dark coloured shale of the lias, resemble the clays and shales belonging to the true coal formation: thus countenancing the idea of the existence of coal, as it is usually found to accompany strata of this description. The occurrence of bituminous shale and of lignite, has often led to the expenditure of large sums, in the expectation of finding the true coal at greater depths, both above and below the true carboniferous formation. It is the light which science has of late years thrown upon the obscurity of these operations, which renders practical geology of such value; teaching us to avoid blind and delusive guides; and saving us from the ruinous effects of ignorant rashness and adventure.

Professor Phillips's map of this eastern part of Yorkshire, published in 1835, exhibits some advantages, of detail, over that of Mr. Young, in 1828; but furnishes very little information as to the coal workings within the Moorland oolitic region.

The carbonaceous sandstone and shales enclose two very distinct layers of fossil plants. The lowest consist of cycadiform fronds, and ferns of different kinds. The upper layer consists of only one kind of equisetiform plants, standing vertically, as if in the attitude of growth.† These are covered by a considerable thickness of sandstones and shales; enclosing a thin seam of coal, which is worked at various places on the moors.

Above these are calcareous strata, and on them are other sandstones and shales, containing small seams of coal and local deposits of fossil plants, with nodules of iron stone. The plants belong to the same tribes of zamiæ cycadea, ferns, and lycopodiform plants, as those below, but the species are generally distinct. Mr. Phillips concludes by remarking on the difference between the fossil vegetation of the true coal formation and those of the oolitic age, in the Yorkshire moorlands; in corroboration of which is the

* F. Burr's Introduction to Geology.

† Young and Bird's Geology of the Yorkshire Coast, Pl. III.—Also Mr. Murchisson on the Brora coal-field, in Sutherlandshire—Geol. Trans. Vol. II. p. 32.

fact, that though one hundred speceies of fossil plants have been described from the former, and not less than fifty from the latter, no one species has yet been found which is common to both situations.

Thin as the coal seams are, they are pretty extensively worked in the interior moorlands. The plants, from which they are derived, are nearly all figured in the works of Young and Phillips, above referred to, and are useful illustrations of the fossil vegetation of the oolitic period, in other positions.

A short extract from Professor Phillips's Illustrations, can scarcely be out of place here:—

"The result of all accurate inquiries into the nature and distribution of fossil plants, is, that they consist of three distinct groups of species, which occupy as many peculiar repositories in the secondary strata. One group lies above the chalk; another occupies the coal measures and mountain limestone.

A cursory observer may, perhaps, be led to confound together the ferns and calamites of the coal district, with the ferns and equisetæ of the oolitic rocks; though, to a botanical eye, their difference is very apparent. But who can mistake the lepododendra of the former; the cycadiform fronds of the middle period; and the dicotyledonous leaves and fruits which abound above the chalk?"*

XXV. NEWCASTLE FIELD, IN DURHAM AND NORTHUMBERLAND.

Part of this coal-field is concealed by the overlying magnesian limestone, the extent of which, of course, cannot be defined, with our present information. The area described upon Mr. Greenough's last map of this region, exhibits seven hundred and eighty square miles, or 499,200 acres. If we had included the millstone grit and shale, we should add seven hundred and fifty miles more. This amount is less than that stated by H. Taylor, a good practical authority—

The part in Durham county,	594	square miles,		=	380,160	acres.
" " Northumberland,	243	"	"	=	155,620	"
	837	"	"	=	535,680	"
Portion excavated,	105	"	"	=	67,200	"
Area yet unworked,	732	"	"	=	468,480	"
					average 12 ft. thick.	

The contents of coal remaining therein, being upwards of nine thousand millions of tons, which, at the rate of the present consumption and exportation from the region, and allowing that only two-thirds of this coal is mined, will not be exhausted until after a period of 1727 years.‡

Professors Sedgwick and Buckland, however, thought this calculation was exaggerated; but the developments of subsequent years appear fully to confirm, and even exceed it. Mr. S. states that there are five good workable seams to the east of the Wear river, amounting to 25½ feet; of which about 16 feet may be depended upon. On the east side of the Wear, the best seams crop out within a short distance, or approach the surface; reducing

* Phillips's Illustrations of the Geology of Yorkshire, Part I. p. 2.
‡ McCulloch's Statistics of the British Empire, p. 86.

the workable quantity of good coal very materially, in that direction. The Professor, in reducing this estimate so extensively, is understood to have in view the prime qualities only, such as now supply the London market, without reference to the inferior beds, which, in Mr. Taylor's calculation, were brought into the account. Thus the difference between the estimates may be much less than appears. Our own admeasurement of the area, it will be observed, is fifty-seven square miles less than H. Taylor's—and we have made no allowance for bad or vacant ground.

Thirty years ago it was estimated that the area of coal in Northumberland county was one hundred and twenty-eight thousand acres, of which one hundred and fifty-five acres were cleared out every year, to supply London and the east of England with fuel. Consequently, that it contained a supply for eight hundred and seventy-five years, from that district alone.

The earliest geological writer necessary to refer to, is Mr. N. J. Winch.* This author quotes several sections showing the extent of coal known at that time. Thus, at the Hartley colliery, in a shaft of five hundred feet, ten seams are traversed, comprising thirty feet of coal, of various qualities. In the Killingworth pit, twenty-seven veins comprise a thickness of thirty-nine feet in a depth of seven hundred feet. At Coxledge, fourteen seams occur in three hundred and fifty-one feet, and contain near sixteen feet of coal. At other collieries the main worked seams amounted to ten, fourteen and a half, twelve, and nine feet. At Montague main colliery, nineteen seams comprise twenty-five and a half feet of coal, in seven hundred and forty feet depth; of which four only are worked, having nine feet aggregate of coal. Percy main colliery, ten seams; three only worked, in eight hundred and seventy feet. Bigge's Main, eighteen veins, of which six or eight are workable; the whole being thirty-four and a half feet of coal, in eleven hundred and sixty feet. Gateshead Fell, fifteen veins, of which eleven are workable, have an aggregate of forty-two feet in eight hundred and three feet depth. At Kell's field, nine worked veins, have thirty feet coal, in five hundred and sixty-two feet. At Newcastle, eight veins, containing twenty-eight feet coal, in four hundred feet. At Sheriff Hill, fifteen seams, have near forty-two feet coal, in eight hundred and four feet depth. Greenfield colliery, in two hundred and seventy-seven feet, has ten seams, and twenty-four feet of coal. Abundant sections might be added, but the foregoing may suffice.

Recent authority gives thirty coal seams and an aggregate of eighty feet thickness, within the northern coal-field. The quantity of coal raised in this region, exported, as well as consumed, amounted in 1813, to about a million and a quarter of Newcastle chaldrons annually; each Newcastle chaldron being double that of the London chaldron, equal to nearly four millions of tons. At this time not less than one hundred thousand tons of small coal were annually burned and *destroyed as waste*, at the mouth of the pits.

Mr. Winch enumerates three principal varieties of Newcastle coal, as follows, viz.

1. The common, or slate coal.
2. Cannel coal—also called Parrot coal; with little bitumen or sulphur.
3. Coarse coal—also called Splint coal; fracture cubical.

This region is important, as containing those immense deposits of excellent fuel, from which not only the metropolis, but a vast circuit of towns and villages on the coast, from Berwick to Plymouth, are supplied.† In length,

* Trans. Geol. Soc. Lond. 1816, Vol. IV.
† Fossil Fuel, the Collieries and the Coal Trade, p. 116.

this coal-field is fifty-five to sixty miles, and in breadth full fifteen miles, on an average.*

A section of a part of this coal region, near Newcastle, was many years ago, published in Rees's Encyclopædia. The whole depth of shaft was seven hundred and thirty-seven feet, and passed through sixteen seams of coal, for the most part quite thin; four only measuring a yard each in thickness.

In 1833, Mr. Winch, from whom we have before quoted, published in the London and Edinburgh Philosophical Magazine, the section of another shaft near Newcastle, sunk at the Gosforth colliery. This was penetrated to the depth of eleven hundred and twenty-eight feet. Forty-three seams of coal were intersected; many of them, as in the foregoing, being very thin. There is a very fine and valuable vein in this region, six feet thick, called the high main coal, highly estimated in the London markets. Three hundred and fifty-four feet below this is another, equally estimated, coal seam, termed the Low main, which is upwards of six feet thick.

One of the greatest coal enterprises ever undertaken, was the sinking the deep shaft at Monk Wearmouth, near Sunderland. This position is four miles beyond the eastern margin of the coal-field, as shown upon the most recent geological maps; and close to the sea, at the mouth of the river Wear.

The shaft was commenced on the 20th May, 1826. In August, 1831, the first coal formation was found, which was only one inch and a half thick. It was not until after eight years and a half of labour, and sinking through the magnesian limestone and other overlying formations, that the first workable seam, of considerable value and thickness, was reached at the depth of fifteen hundred and eighty-four feet! The sinking was continued, with unabated energy, and at the end of near nine years had reached to above sixteen hundred feet, when the adventurers were rewarded at length by striking a valuable bed of coal.† The shaft and workings were two hundred and seventy-nine fathoms, or sixteen hundred and seventy-four feet deep in 1843.‡

An account of a series of experiments made in this shaft, and in the first named coal seam, at the depth of two hundred and sixty-four fathoms, or fifteen hundred and eighty-four feet, to determine the temperature, is related by Professor Phillips, in Vol. V. London and Edinburgh Philosophical Magazine, p. 446, 1834. This shaft is twelve feet diameter; the pit-top is eighty-seven feet above ordinary high water; its depth below the sea fourteen hundred and ninety-seven feet. The result of his observations was an augmentation of temperature of one degree for every twenty yards in descending. It was also found that the water which sprung up through the floor of the coal was *salt;* and that the gas, which is constantly bubbling up from the cellular reservoirs, was hotter than the water, by no less than a degree. The upper coal seam is six feet thick.§

It was only in April, 1846, that the workmen reached the Hutton seam, four feet ten inches thick, and nineteen fathoms below the Bensham seam. This coal is of excellent quality; and thus, after twenty years' labour, the value of the colliery is fully proved, and excites much interest in scientific

* Mr. Greenough's Geological Map of England and Wales, 1839.

† Fossil Fuel, p. 188. Also Mining Review, July, 1835, p. 86. Also Geology in 1835, J. Lawrence.

‡ Central Mining Commission Report, p. cviii. 1843.

Philosophical Magazine, December, 1834.

circles from the circumstance of its being the deepest coal mine in Great Britain, being now two hundred and ninety-nine fathoms, or seventeen hundred and ninety-four feet, in depth below the surface.

The South Hetton Company commenced a shaft at Murton colliery, on the 19th of February, 1838. After many difficulties, of unusual character and magnitude, which are detailed by Mr. Dunn, p. 239, the Hutton seam was struck at the depth of two hundred and forty-eight fathoms, or fourteen hundred and eighty-eight feet from the surface, on the 15th April, 1843.

Miscellaneous Details.—Mr. Sopwith has completed one of those best of all illustrations, a *geological model* of this region. It illustrates the nature of stratification, position of the coal seams, their faults or dislocations, and other phenomena incidental to the mineral district; all of great importance to the practical miner, as well as the owners. We hope that, ere long, all the great mineral regions will receive the same description of illustration.

In 1842, M. Piot published, in the *Annales des Mines*, an account of the coal mines in the environs of Newcastle-upon-Tyne, accompanied by a great number of diagrams and statistical tables. The article is too long and too detailed (extending to two hundred and seventy pages,) to admit of but passing notice in this sketch; but it abounds in information, and refers to most of the authorities who had previously written upon this region. We have availed ourselves of this work, in several instances, in the statistical part of this abstract.*

In 1843, Mathias Dunn, Esq., C. E. communicated to the Newcastle Mechanics' Institute a memoir "on the rise and progress of colliery engineering," in the Newcastle coal-field.

We infer from this paper, that the coal of the northern part of the Newcastle basin contains a larger amount of bitumen and volatile matter [extending to 51 per cent] than those of the southern part: and that the latter contain a much greater quantity of carbon [72.71 per cent.] than in any other part of the region. Consequently, those coals which are derived from the neighbourhood of the Garesfield and Auckland collieries, have a considerable preference, and are destined, mainly, to the supply of the engines of the metropolitan and continental railroads.

Salt Water of the Deep Mines.—From this source we also learn, that the water in the deep collieries of the Tyne and Wear is *uniformly salt;* accompanied with various other admixtures. So highly impregnated is the mine-water of Birtley, Walker, Lambton, &c. that extensive salt-works are there erected, and the produce is brought into the market for sale.

The mine-water, at St. Lawrence, near Newcastle, exhibits the following analysis:†

	Grains		In 100 parts.
Chlorite, or Muriate of Soda, or Common Salt,	2938.24	=	72.8
Chlorite of Calcium,	854.08	=	21.1
Chlorite of Magnesia,	193.92	=	4.8
Sulphate of Lime,	44.88	=	1.1
Sulphate of Iron,	7.28	=	.2
Obtained from one gallon of brine,	4038.40		100.0

* Mémoire sur l'exploitation des Mines de Houille de Newcastle, par M. Piot, Elève-Ingénieur des Mines.

† Mining Journal of London, January 13, 1844.

The water of the Birtley colliery is of a high temperature, and holds nearly three times the quantity of common salt contained in sea water.

Mr. Dunn states that *salt water* is a phenomenon peculiar to the Newcastle coal-field, the origin of which remains as yet a perfect mystery. In the Birtley colliery, above referred to, the salt water flows from a fissure in one of the dykes. Its origin, therefore, may be very deeply seated, and the brine springs may ascend by means of the fissures and dykes, from saliferous deposits in the Silurian series of rocks, such, for instance, as exist on a large scale in the Onondaga salt groupe of New York state, U. S.

The flow of salt water in the Birtley colliery is nearly eleven hundred gallons per hour. At Butterby colliery, near Durham, is another salt spring, long known, which also rises from fissures in the Whin dyke, where it crosses the river Wear.*

PRODUCTION AND CAPABILITIES OF THE NEWCASTLE COAL-FIELD.

It was reported in 1826, that the Newcastle district furnished employment in mining, delivering, transporting and retailing the seaborne coals, to more than sixty thousand persons. Mr. H. Taylor, in 1829, stated that the amount of coals carried coastwise from Durham and Northumberland, was 3,300,000 tons, and including the home consumption, the quantity mined was 3,960,000 tons. The power of working was near six millions.

Table of *Shipments of Coal* and Coke from the Collieries in the north of England, exclusive of those of Blythe and Seaton Sluice, carried coastwise, including those delivered in London, in Tons †

Years.	For Home Comsumption only.			
	Tyne Newcastle.	Wear Sunderland.	Tees Stockton.	Total of Tons.
1824	1,852,393	1,263,669		3,116,062
1826	2,119,061	1,373,955		3,493,016
1828	1,768,882	1,321,996	85.368	3,176,246
1836	2,280,713	971,458	916,440	4,228,611
1838	2,459,728	948,429	1,219,938	4,628,095
1840	2,281,343	868,228	1,367,532	4,517,103
1842	2,350,480	859,231	1,501,596	4,711,307

Statement of the *Registered Tonnage* of the Port of Newcastle; together with the number of Entries and Clearances in the Foreign and Home Trade, chiefly in coal, from thence.

Years.	Registered shipping belonging to the port.			Trade—Loaded Vessels.				
				Foreign.		Home Trade.		
	Number of vessels.	Tonnage.	Seamen.	Vessels entered.	Vessels cleared.	Vessels entered.	Vessels cleared.	
1835	1,076	211,173		373	1,913	2,725	13,061	Previous to
1836	1,080	213,907		430	2,381	2,703	13,465	the tariff.
1838	1,186	229,425		601	2,822	3,195	13,990	Viz: duty
1840	1,327	261,164		789	3,394	3,031	13,755	free.
1842	1,330	270,796	13,500	612	4,230	2,704	13,934	Subject to
1843	1,379	277,771		708	4,088	2,513	13,633	the tariff.

* Philosophical Transactions, 1684.

† Report of Committee on the Coal Trade of London, 1838.

	Tons Shipped.
We have shown by the foregoing table that this amount of shipments had increased in 1835 to - - -	4,286,419
And in 1842 to (exclusive of coals conveyed inland and of consumption in the country,) - - -	6,123,282

While the productive power now reached to 13 millions of tons.

The average tonnage of the collier vessels is 200 tons. The mean number of voyages which these vessels annually make, between Newcastle and London, is ten; but several have made as many as fifteen.

GENERAL COAL TRADE, FOREIGN AND DOMESTIC, OF THE NEWCASTLE COAL DISTRICT.

General Shipments of Coal and Coke from the Newcastle or Durham and Northumberland coal-field; at the three principal ports of the Tyne, the Wear, and the Tees, [those of Newcastle, Sunderland and Stockton:] also from the Collieries north of the Tyne.

This table comprises all shipments, both for foreign and home trade or coastwise.

For Foreign and Home Consumption.					
	River Tyne.	River Wear.		River Tees.	
	Newcastle.	Blythe and Seaton Sluice	Sunderland.	Stockton.	
Years.	Tons, [reduced from chaldrons of 53 cwt.]	Tons.	Newcastle chaldrons of 53 cwt reduced to 20 cwt. tons.	Tons.	Total exported from the collieries in the north of England. Tons.
1710	472,092		348,528		820,620
1776	1,004,000				
1792	1,212,180		762,500		1,974,680
1800	1,815,990		804,166		2,620,156
1810	1,998,100		987,460		2,985,560
1820	2,173,540		1,140,470		3,314,010
1828	2,078,680	no returns.	1,411,140	54,290	3,544,110
1832	1.682,649	"	1,196,347	281,960	3,160,956
1834	1,850,962	101,223	919,433	285,765	3,157,383
1835	2.312,401	133,184	1,483,108	357,726	4,286,419
1836	2,696,562	no returns.	1,141,825	953,383	4,851,770
1838	3,013,903	"	1,256,597	1,307,637	5,578,137
1839	2,717,373	"	1,284,580	1,420,485	5,422,438
1840	2,875,254	"	1,311,215	1,500,374	5,686,843
1841	3,148,562	"	1,346,510	1,646,403	6,141,275
1842	3,216,761	"	1.224,117	1,682,404	6,123,282
1843	2,468,481	"	2,355,486		

The shipments from the small ports north of the Tyne are not included in this statement.

"LIMITATION OF THE VEND" OF COAL FROM THE NORTHERN MINES.

The Coal Association of the north of England have fixed a standard; and annually, determine, from this arbitrary base, the proportion which ought to be furnished by each colliery or district; having reference not only to the power of extraction from each of them, but also to the quality or the coal which they produce.

Thus, in 1835, the proportions fixed were the following:

	Newcastle chaldrons of 53 cwt.
For the Tyne,	939,000
For the Wear,	585,000
For the Tees,	160,000
Hartley, Cowper and Netherton,	68,750
	1,752,750

This regulation, it appears, is only operative on the collieries which belong to the Association.

In 1838 the interests stood thus:

	Mines held by members of the Association.	Mines not in the Association.	Total in the Newcastle district.
District of the Tyne,	45	3	48
" " Wear,	6	3	9
" " Tees,	9	8	17
	60	14	74*

This "Limitation of the Vend" has, according to Mr. Porter, existed, with some partial interruptions, since the year 1771; and is condemned by some economists, as "a systematic combination among the owners of collieries to raise the price of coal to consumers, by a self-imposed restriction as to the quantity supplied."

A comparative statement of the quantity of coals imported into *the Port of London* from the Ports of Newcastle, Sunderland, Stockton on Tees and Blythe.

Years.	Newcastle.	Sunderland.	Stockton on Tees.	Blythe and Seaton Sluice.	Total from the Northern Coal-field by Sea.	Number of Ships.
	Tons.	Tons.	Tons.	Tons.		
1828 to 31 av.	1,294,564	560,301	27,603	64,392	1,946,860	
1832 to 33 av.	1,160,431	613,916	198,941	56,735	2,030,023	
1834	1,142,903	559,105	221,971	64,268	1,988,247	6,916
1835	1,266,755	629,554	230,174	65,046	2,191,529	7,299
1836	1,235,406	743,849	268,222	71,775	2,319,251	7,648
1837	1,279,890	834,862	370,530	71,856	2,557,138	8,261

The foregoing and following tables show the increased production of coal in the north of England.

In 1773 there were only thirteen mines or collieries worked in the Newcastle field. In 1800 this number had advanced to forty-one. Thirty years afterwards, in 1830, fifty-nine collieries were in operation, having an annual productive power of 8,123,922 tons. In 1835 the number had advanced to seventy-six, and in 1844 to one hundred and thirty collieries.

In 1843 the productive power was estimated to be equal to 13,000,000 of tons.†

At the same time it must be remarked, that the increased number of colliery adventures furnishes by no means a proof of the positive prosperity of the trade: on the contrary, it suffers from the excessive competition and speculation.

* Annales des Mines, Vol. I., 1842, p. 345.

† Angleterre, Faits commerciaux, Mai et Juin, 1844.

EXPORTATION.

The following table shows the shipments of coal, coke, and cinders to *foreign countries*, from the ports of the Newcastle coal-field, in tons of 2240 lbs.*

Years.	Tyne. Newcastle.	Wear. Sunderland.	Tees. Stockton and Hartlepool.	Total exported. Tons.
1810	45,720	5,085		50,805
1820	118,788	38,226		157,014
1828	157,211	60,793		218,004
1833	233,709	176,487	3,700	413,896
1834	230,342	149,956	9,988	390,286
1836	415,849	170,367	36,943	623,159
1838	554,175	308,178	86,699	949,052
1840	593,911	442,987	132,842	1,169,740
1841	750,585	408,515	169,345	1,328,445
1842	791,981	366,451	178,342	1,336,774
1843	815,434	530,584	[in 3d col.]	1,346,018
1844	602,152	220,434	237,166	1,059,752
1845	1,069,737	428,400	286,851	1,784,988

In May, 1844, it appears, by a statement published by the coal owners, that the number of collieries and workmen or working people therein, was as follows:

Districts.	No. of collieries.	No. of work people.
Tyne,	65	15,556
Wear,	31	13,172
Tees,	24	4,211
Blyth,	4	1,051
	124	33,990

Employed above ground,	8,607
Below ground,	25,383
	33,990

The average rate of earnings of the workmen in this coal-field, in 1844, as shown by the coal owners' statement, was, before the restriction or limitation of the vend, 3*s.* 9½*d.* per day, = \$0.91; and subsequently it was 3*s.* 2*d.*, = \$0.76 per day.†

LIMITATION OF THE VEND.

In 1844 there were one hundred and thirty collieries in the north of England coal-field. Mr. Dunn remarks, that "so disproportionate has been the augmentation of power of production to the demand, that the basis of 1843 only allowed of a real vend of 44 per cent.; or, in other words, a colliery standing upon a basis of 50,000 chaldrons, realized a vend of 22,000 chaldrons; whereas the basis of 1838 allowed of a vend of 80 per cent., or 40,000 chaldrons."

The increased facilities for conveying coals inland, has had an unfavourable influence on the coasting trade. It was shown, in 1844, that no less than 300,000 tons which would otherwise have been brought by sea, had been superseded by the inland coal.

We add the following short table of the periodical VEND on the rivers Wear and Tyne, including both coastwise and foreign shipments.

* Report on the Coal Trade of London, 1838, and other returns.
† Dunn, on the Coal Trade, p. 37, 216, 229.

Years.	Tyne or Newcastle N. chald. of 53 cwt. each.	Wear or Sunderland N. chald. of 53 cwt	Years.	Tyne or Newcastle N. chald. of 53 cwt. each.	Wear or Sunderland N. chald. of 53 cwt.
1800	585,280	303,459	1825	738,473	537,327
1805	602,399	319,262	1830	729,075	523,567
1810	649,552	372.631	1835	698,000	410,879
1815	692,643	354,893	1840		497,546
1820	801,339	430,397	1845		533,713

Those coals which are consumed within the district for lime burning, glass works, &c., are exempt from the river duty of 6*d.* per Newcastle chaldron. We possess no record of these, or means of judging of the amount of consumption.

Profitable duration of the Newcastle or Durham and Northumberland Coal-field, according to the views of different writers.

We have seen, by the calculations of H. Taylor, that the coal will not be entirely exhausted, if it be desirable to work out the whole, under 1727 years.*

Dr. Thomson, on evidently erroneous data, one thousand years.†

Professor Sedgewick, the greater part of the "best seams," in four hundred years.

Mr. Bakewell, on the authority of others, only the principal coal beds, in three hundred and sixty years.‡

From subsequent proving of the coal beneath the limestone, added to the data furnished by Mr. Buddle, and making ample allowances, it seems clear that Mr. Taylor's computation is below the probable result.

All these authorities coincide, however, in one particular; that, in proportion as the supply decreases and the expense increases, as regards the best description of Newcastle coals, so will the consumers have to resort to the comparatively unwrought regions of Scotland and South Wales. We may add, also, that these considerations will have no small influence in compelling the employment of a much more cleanly and economical description of fuel, in the shape of anthracite, as in the United States of America. Hence the day will arrive when London, renowned as one of the most dirty, dark, and smoky capitals of Europe, whose two and a half millions of inhabitants breathe an atmosphere surcharged with noxious matters, may rank among the most cleanly; and may yet enjoy as pure and salubrious an atmosphere as any of the great cities of the old or new world now do.

Let those who have experienced, with the writer, during many long years of residence in the cities on both sides the Atlantic, all the practical advantages, as regards domestic economy, of one description of fuel, or have learned to endure the demerits of the other, say, whether the change contemplated in the preceding paragraph should not be hailed as an incalculable blessing to the inhabitants of the British metropolis?

No one who has enjoyed the purity and cleanliness of an American city, Philadelphia, for instance, on transferring himself to London, in the winter season, would feel inclined greatly to condemn the Parliament of 1306, which complained to the king, that by the use of coals, the air had become

* History of Fossil fuel. Extracts from Reports of Committees of the House of Commons.
† Dr. Thomson, in Annals of Philosophy.
‡ Bakewell, 3d edition, p. 178.

infected with noxious vapours; nor wonder at the proclamation which followed, against their further use in the city.

Number of Persons dependent on mining the Newcastle Coal.

In 1792, Dr. McNab estimated the number of persons employed above and below ground, including their families, 64,725.

In 1828, number, exclusive of their families, but comprising boatmen and seamen, 45,500.*

In 1841 it was communicated to the government by a deputation of coal owners, that the capital embarked in the different branches of the northern coal trade, amounted to £9,500,000, = $46,075,000, employing 33,000 men and boys, and 6873 ships, whose tonnage was 978,065 tons.

In 1844 the coal owners stated that in the one hundred and twenty-four collieries of this district, there were employed 8607 workmen above ground, and 25,383 below ground. Total 33,990.

In 1847 the Newcastle district gave employment to 40,000 persons, of which number, however, only 10,000 persons worked under ground.

Estimate of persons engaged in the export and shipping coal trade of Durham and Northumberland, and depending upon it for their support.

Employed in the mines, 5500 men, 1400 boys over ten years old. Dependent on these for their subsistence, 2800 women, 1600 children under ten years of age. Total 11,300.

Employed in the transport of the coals [9132 cargoes in 1840] in British vessels, averaging 220 tons each, besides those of the foreign shipping, 4200 seamen, 1400 boys. Dependent on these for support, at least 1900 women, 1900 children. Total 9400.

Total, besides those indirectly connected with the mines and the trade, 20,700.†

Mr. Buddle's estimate, made in 1830, is much larger. Working population of the mines, 21,000; workmen transporting and loading the coal, 2000; sailors, &c., in the coal shipping, &c., (1400 vessels,) 15,000. Total, exclusive of the women and children dependent on these for support, 38,000 workers.

The coal trade is subject to great fluctuations. The year 1846 was one of great depression and competition in the north; in so much that it was announced that the best Wall's-end were sold in the ports of production as low as 20*s.* 6*d.* per Newcastle chaldron of 53 cwt.; equal to 7*s.* 9*d.* per ton, free on ship-board.

Many of the principal collieries of the best Wall's-end coals, lie upon an average, about nine miles from their respective ports of shipment, to which places they are carried and shipped, generally, for 2*s.* 6*d.* per Newcastle chaldron. The common coals are from fifteen to thirty miles from the ports of shipment, and nearly all of them are conveyed by public railways. The inferior coals were shipped in June, 1846, for from 12*s.* to 15*s.* per Newcastle chaldron, equal to 4*s.* 6*d.* to 5*s.* 6*d.* per ton; and, in many places, it was stated, the cost of their transit from the pit's mouth to the ship, amounted to half the selling price. The miners employed at the collieries producing second and third rate coals, were, at this time, little more than half their

* Parliamentary Report, 1829.

† Correspondent of the Times. We think this statement is much underrated, unless it is meant to apply to the trade of the Tyne only, as is very probable; and in that case it would sufficiently conform to Mr. Buddle's statement in a previous year.

time at work, and some of the inferior coals were worked almost expressly for the purpose of making coke.

Shipping employed in the Coal Trade of the North of England.—British Trade—ships, 4031; tonnage, 702,575. Foreign Trade—ships, 2842; tonnage, 275,490.

Coal Trade with France.—By French official returns it appears that the relative proportion of vessels employed in transporting coal from England to France, was in 1842 as follows:—French vessels or cargoes, 675; tonnage, 54,884. English vessels or cargoes, 3160; tonnage, 312,382.—Total, ships, 3835; tonnage, 367,166.

There is some discrepancy in this and preceding accounts; inasmuch as the French official return of English imported coal in the same year, 1842, is elsewhere given at 515,975 tons.

In the Report of the Midland Mining Commission, in 1843, are introduced detailed statistics of the principal collieries on the Tyne, the Wear, and the Tees, in that year, from whence the following summary has been prepared.*

Districts.	Average depth of Shaft, Fathoms.	Number of Pits or Collieries.	Men and Boys employed.	Engine power. Horses.	Coal raised per annum	Price per ton.
Tyne River,	85	92	12,833	9,690	2,468,481	7*s.* to 10*s.*
Wear River,	75	88	11,558	8,907	2,355,486	8*s.* 6*d.* to 11*s.* 6*d.*
Tees River,	55	12	1,379	800	1,682,404	8*s.* 6*d.* to 10*s.* 6*d.*
In 1843,		192	25,770	19,397	6,506,371	

Statement of prices paid at Newcastle and Sunderland, for coals *of the first quality*, shipped for London at the beginning of June in each year, from 1801.†

Years.	Price per ton.	Years.	Price per ton.
1801-2-3	10*s.* 4*d.*	1826 to 1828	13*s.* 6*d.*
1804 to 1808	11*s.* 6*d.*	1829	12*s.* 9*d.*
1809 to 1820	13*s.* 0*d.*	1830 to 1831	12*s.* 4*d.*
1821	12*s.* 8*d.*	1832	12*s.* 3*d.*
1822	11*s.* 11*d.*	1833	10*s.* 6*d.*
1823	12*s.* 8*d.*	1834	10*s.* 9*d.*
1824	13*s.* 0*d.*	1835 to 1841	11*s.* 0*d.*
1825	12*s.* 8*d.*		
		Average of forty-one years,	12*s.* 1*d.*

Coal Mining operations in the Magnesian Limestone of South Durham.—We have alluded to the practical enlargement of the coal bearing area of this region, when speaking of the extraordinary perseverance exhibited in sinking shafts through the magnesian limestone.

An account has been published, by Mr. Stanley, "of the coal mining operations in the magnesian limestone district of South Durham;" from which source we collect the following facts.

The time is not long past, when the prevailing opinion was, that no coal lay under the magnesian limestone. This was even held by men of practical and scientific attainments; and even if found, it was asserted, among

* Report, p. cvii.

† Chiefly from Mr. Porter's Statistics.

others by Mr. Winch, "that the coal is deteriorated in quality, when covered by limestone."

This has been completely disproved by the surprising works, pursued under great disadvantages and enormous cost, at the old and South Hetton collieries, and half a dozen equally stupendous undertakings, all of which have proved eminently successful.

Liability to spontaneous ignition.—This occasionally occurs at the pit's mouth, after the coals have been for some months exposed to the atmosphere and rain, but no instance has occurred where vessels or dry cargoes have been set on fire, by having coals on board, nor has there ever been an objection made to insuring vessels having coal as ballast. On very rare occasions, it has been stated, in evidence, coals, accumulated in a warehouse, have been known to ignite, when put in wet.

XXVI. BERWICK COAL DISTRICT, AT THE NORTH-EAST ANGLE OF ENGLAND.

Mr. Winch, in 1814, said of this region, that it is of more importance for its lead* than its coal, and that the coal seams are smaller than in the Newcastle district. The mines are of inconsiderable depth, the deepest being, in 1814, only 45 fathoms. Within this thickness, at Shilbottle colliery, are four coal seams, whose aggregate thickness is only five feet. Several sections might be detailed of similar character, were it necessary.

The Berwick coal-field is situated in the lower beds of the mountain limestone, which rests upon, and is interstratified with, thick beds of ferruginous sandstone; underneath which again is a very regular and tolerable seam of coal, 4 feet thick. At Scremerton, the deepest explored part of the district, there are eight coal beds, from 3 to 5 feet each, comprised within a thickness of 146 fathoms.†

XXVII. MILL-STONE GRIT AND LOWER COAL MEASURES OF THE NORTH OF ENGLAND.

In former geological maps of England, there appeared an immense coal region extending along the borders of Scotland, which occupied an area of near eleven hundred square miles.

The true coal formation within these limits is very much curtailed on the recent geological maps, which exhibit towards Berwick a small insulated coal-field about 18 or 20 miles square, while the remaining portion of the eleven hundred square miles, is occupied by the lowest members of coal grits, shales, and carboniferous limestones; which strata are perforated, in numberless places, in working the inferior coal seams. About one half of this area appears to be occupied by the upper metalliferous limestone; while the summits of the hills and high lands, are composed of the coal shale and grit, forming about twenty separate masses, or islands as it were, within the main area.

An account of this region was published in the Philosophical Magazine, in 1831, by Mr. Winch. From statements furnished by Mr. Fenwick, there are proved in the Berwick district, ten beds of coal, varying from 4 inches to $5\frac{1}{2}$ feet, within the depth of two hundred and twenty-two feet; and in the thickness of 138 feet below, six other beds of coal were perforated, the thickest of which is two feet.

* The average annual shipments of lead from this region, coastwise, for 10 years preceding, being near ten thousand tons; and each ton contains, on an average, twelve ounces of silver. In 1840, 6,000 to 7,000 tons pig lead, 2,000 tons sheet lead, from Newcastle alone.

† Dunn, p. 9.

Of eight coal seams usually worked, averaging three feet each, the quality generally, is by no means good. Some of it is only applied to lime-burning and such ordinary purposes; but one seam of four feet is in tolerable repute for household consumption.*

VEGETATION OF THE TRUE COAL FORMATION.

Fossil Forest of South Staffordshire.—In the Quarterly Journal of the Geological Society, February, 1845, is a description of what is styled a fossil forest in the Parkfield colliery, near Wolverhampton, by Mr. Beckett. It consists of numerous stumps of trees, standing upright, and evidently having grown on the spot. They are perfectly bituminized, but broken off about two inches above the level of the coal measure. The thickness of the coal is only five to ten inches. Beneath this coal was the shale bed in which the trees must have grown, and this (as now compressed and indurated) is 3½ inches thick, of which half an inch is fire-clay. The tree, particularly examined, was four feet in circumference, having a broad base, without a tap-root. The authors have not determined the name of these trees, only that their bark differs from calamites or sigillaria. Seventy-three of these trees were counted in an area of about a quarter of an acre. A remarkable circumstance attended this locality. On breaking through the shale, in a second seam of coal, was discovered what at first appeared to be a prolongation of the roots of the first trees; but, on further search, another forest was found below the other. The trees appeared to have grown thickly together, as three were laid bare in as many yards square. The thickness of the coal bed here was 17 inches to two feet; and the substratum consisted of a shale, similar to that above, and four or five inches thick. Below this was a bed of fire-clay, seven or eight inches thick, reposing upon a third bed of coal, in which traces of trees were subsequently observed.†

This communication is followed by a more detailed one, by Mr. William Ick, who pronounces the stumps to be the remains of fossil dicotyledonous trees. He states that the terrace of coal exposed, at the out-crop of the *bottom coal*, exhibits on its surface one of the most remarkable accumulations of the fossil remains of the vegetation of the coal period, ever exposed to view. These trunks are apparently dicotyledonous, broken off at the root, and several of them are more than eight feet in circumference; the prostrate trunks lying across each other in every direction. One of these measured 30 feet, another 15 feet, in length, and others a few feet less. Impressions of stigmaria, lepidodendron, lepidostrabi, and calamites, are found in the shale, accompanied by the teeth and fragments of fishes.

Not the least curious circumstance, the author remarks, in connection with this deposit is, that although the whole is not more than twelve feet in thickness, there are at least three distinct beds of coal, each of which exhibits on its surface the remains of an ancient forest of large trees.

The third forest was at the depth of five feet below the fire-clay of the second. The evidence is not slight that most of these trees were allied to coniferæ; and few who have carefully compared the lepidodendra with the leaf-bearing stems of the yew, spruce-fir, or various species of pine, can have much doubt of the fossil plants being allied to these recent ones.‡

* Philosophical Magazine, 1831. Also Mining Review, Vol. V. p. 115.
† Quarterly Journal Geological Society, No. I. p. 41, 1845. ‡ Ibid. p. 43.

In the coal grit of this same coal-field, near Darlaston, Mr. John Dawes has noticed an exceedingly well preserved specimen of a fossil tree. It is 39 feet in length, 10 yards above the nearest bed of coal. Traces of four or five branches were observed, showing a remarkable uniformity in thickness.

The whole length of this splendid fossil, so far as it is yet traced, is upwards of 44 feet, and its greatest breadth is not more than 20 inches. Sections of the wood show that the structure is remarkably perfect, and prove the tree to have been coniferous.*

SILICIFIED TREES IN NEW RED SANDSTONE, NEAR COVENTRY, ENGLAND.

Prof. Buckland has furnished some details of the occurrence of fossil wood in this formation, at many localities. All these specimens are either referable to decided coniferæ, which have distinct concentric lines of growth, or exhibit a compact structure, in which neither large vascular tubes nor concentric lines of growth are visible.† Dr. Mantell suggests that it is not improbable that further research in this formation may bring to light fern-stems like those of Chemnitz in Saxony.‡

In a portion of the new red sandstone group, several species of an extinct genus of coniferæ, named *Voltzia*, are found at Soultz-aux-bains, near Strasburg.§

FOSSIL VEGETATION.

In the Lias ferns and flags occur—gigantic reeds and canes in the alum shale of Whitby; and euphorbia on the overlying sandstone, with leaves of plants allied to cycadea, and to the palm tribe.

The bituminous indications in the lias clay slate have frequently led to fruitless researches for coal. Mr. A. Brongniart recognized at least fifteen species of ferns in this formation, in the Southern Alps; besides lepidodendrons, sigillariæ, stigmariæ, and calamites.

Jet occurs in some abundance in the cliffs of alum shale on the Yorkshire coast, which, according to Dr. Mantell, were celebrated in the early centuries for the production of this substance. At Whitby and Scarborough, extensive manufactories of ornaments and trinkets of jet are established. This substance is a compact lignite, the vascular tissue of which may be detected even in the most solid masses. When prepared in very thin slices it appears of a rich brown colour, by transmitted light, and the woody texture is visible to the naked eye.|| We have had in our possession a beautiful cast or impression of an ammonite in this jet.

FOSSIL VEGETATION OF THE LOWER OOLITE OF YORKSHIRE.

A paper, by a distinguished geologist, on "the occurrence of stems of fossil plants in vertical positions, in the sandstone of the inferior oolite of the Cleveland Hills," in Yorkshire, shows that these plants, (*equisetum columnare,*) must, like those of a later period in "the dirt bed" at Portland, have grown in the position in which they now occur. The author therefore concludes, that during the formation of the sandy *lower* oolite of Yorkshire, the dark shale beds, in which the equisetæ still seem to be rooted, were exposed to the atmosphere—that these stems have never been detached

* Quarterly Journal Geological Society, No. I. p. 46.
† Proceedings Geological Society of London, Vol. II. p. 439.
‡ Mantell's Medals of Creation, p. 129. § Wonders of Geology, p. 685.
|| Mantell's Medals of Creation, 1844, Vol. I., p. 85.

from the place of their growth, but have been first gradually silted up, and then buried under the accumulations of an estuary;—that afterwards these vegetable and carbonaceous strata were covered by a sea in which the shells of the middle oolite were deposited.*

A list of the fossil plants of the inferior oolite coal-beds of Yorkshire, has been supplied by Mr. W. C. Williamson. One bed of shale contains a vast number of plants, amounting to above forty species.

For description of the oolite coal field of Yorkshire, and its vegetable characters, see No. XXIV.

For the Brora or Sutherlandshire oolite coal formation, see No. XXXVI.

1. *Oolite Coal.*—Dr. McCulloch observes, that the lowest or Oolite class of lignites is more frequently, perhaps, akin to coal than to the woody lignites; though the latter substances occur also in various forms. Strictly speaking, lignite occupies an intermediate station between peat and true coal.†

Kimmeridge Coal—Lignite of the latest oolite age.‡

This substance is of limited extent, yet possesses some interest, as affording to "the Father of English Geology" a very appropriate and distinctive name for the formation in which this lignite occurs, on the coast of the Isle of Purbeck.

The Kimmeridge coal in fact is little more than a highly bituminous shale, locally called *stony coal*, the specific gravity of which is 1.319. At various points, along the range of this formation through England, in Oxfordshire, Berkshire, Dorsetshire, &c., unsuccessful attempts have been made, by sinking shafts, to find true coal, and remain so many mementos of the ignorance of the times.

At Great Kimmeridge, have, for many years, been found, what the country people call '*coal money*.' They occur generally on the top of the cliffs, 2 or 3 feet below the surface; enclosed between two stones set edgeways, and covered by a third, together with the bones of some animal. This "coal money" is generally from 2 to 3½ inches in diameter, and a quarter of an inch thick. They are circular, on one side plain and flat; on the other side convex, with mouldings. On the flat side are two, sometimes four, small round holes; perhaps the centre holes by which they were fixed to the turning press. They are supposed to be either amulets or money.§ There are few English museums or geological collections, but contain specimens of these singular, ancient, and unaccountable bodies, called *coal money*. Dr. Fitton has contributed many useful details in relation to the Kimmeridge clay formation, and its supposed coal.|| It contains marine fossils, but we believe no vegetable remains.

VEGETATION OF THE GREAT OOLITE PERIOD.

In the Stonesfield Slate are abundance of terrestrial plants:—fragments of trees, of the dicotyledonous class, branches and leaves of several species of zamia and cycas and of others which nearly resemble the thuja and the ginger plant of modern botany. Several species of seeds and fruits also occur here.

* Proceedings Geol. Soc. London, Vol. I. 391—also Vol. II. p. 431.
† Dr. McCulloch on the Lignites--Quarterly Jour. Sci., Vol. XX. 1826, p. 205, 231.
‡ Quarterly Journal of Science, Vol. 20—McCulloch. Strata identified by Organic Remains—William Smith.
§ Coneybeare and Phillips' Geology, p. 177. || Dr. Fitton on the strata below the Chalk.

Lacustrine or fluviatile reeds, flags and grasses, with ferns and masses, are abundant, and more nearly resemble the plants of the Yorkshire oolite coal than those of the regular coal formation.

Fossilized wood also prevails, more or less, in the Forest marble; in the Oxford clay; and in the calcareous grit of the Coral Rag.

In the oolite near Scarborough is a species of *Pterophyllum*—recently figured by the author of the "Medals of Creation." The fruits of cycadeous plants are very fine, in the same position.

Ferns, differing from known species, occur in the iron sand, accompanied, according to Dr. Mantell, with branches, stems and foliage of plants related to the cypress or thuya. Casts of seven species of vegetables, resembling *Euphorbiæ*, gigantic reeds, and arborescent ferns, abound in the Tilgate limestone of Sussex; possessing some resemblance to tropical plants. Dr. Mantell describes a plant of the genus *Carex*, as common on the Tilgate stone, and the Stonesfield slate. Silicified stems of monocotyledonous plants abound in the ferruginous sandstone of Hastings. No trace of structure was afforded by the miscroscopical examination of the lignite of Tilgate forest, by Dr. Mantell; from which he infers that the wood was not that of Coniferæ; since their vascular tissue is easily detected in coal,—but of plants possessing a less durable organization.*

Marine algæ and fuci are said to occur in the slate of Stonesfield, in the same bed with marine, amphibious, and terrestrial animals; and beautiful preserved specimens of zamia occur in the lias shale of Dorsetshire.

Besides the coal of the Oolite period, described in Yorkshire, &c., England, it is known in other parts of the world, as in Piedmont, Lombardy, the Alps, Scania in Sweden, Richmond in Virginia, in Istria, in Cutch, Hindostan, in Brora, Scotland.

Lignites, silicified and calcareous vegetation, although not always sufficiently abundant to form coal beds, occur in numberless parts and positions of the Oolitic group, in England, Illyria, Silesia, France, the Andes, Lombardy, Savoy, and Piedmont.

In the shales of the American coal of Richmond, Virginia, Mr. Nuttall, many years ago, recognized the Zamia or Cycas, and the leaves of one of the Scitamineæ, allied to ginger; and also some enormous flaccid-leaved gramineous plant. These, with the presence of fossil fishes, described by Mr. Redfield, and some other plants lately noted by Professor W. B. Rogers, point out the Oolitic age of this interesting coal-field.

The result of a late examination of the Stonesfield slate, by Messrs. Brodie and Buckman, is, that it occupies a much more considerable extent in the Cotteswold range of Hills, than has been heretofore suspected: those gentlemen having traced it over an area of fifty miles. They are of opinion that it was deposited by the same sea which formed the Great Oolite itself; and that it partly owed its origin to certain mixed conditions, arising from the influx of rivers into an ocean, interspersed with numerous scattered islands, abounding in a luxuriant vegetation, and inhabited by numerous terrestrial animals.†

2. *Lignites of the Portland or Upper Oolite, in England.*—Among the earliest notices of these very interesting vegetable deposits, of the Portland and Purbeck series, we find those of Mr. Webster.‡ They were followed

* Dr. Mantell's Medals of Creation, 1844, Vol. I. p. 87.
† Quarterly Journal of the Geological Society, No. 2, p. 223—1845.
‡ Letters to Sir Henry Englefield, by Mr. Webster.

by the details embraced in the comprehensive geological sketch of Messrs. Coneybeare and Phillips, in 1822.* To these succeeded Mr. Martin's Geological Memoir on a part of western Sussex, in 1828, and Professor Buckland's paper on the fossil plants in the oolite of Portland,† also in 1828. Mr. De la Beche's account of the "organic remains of the Wealden Rocks of England," in 1831; and Dr. Fitton's "Observations on some of the strata between the chalk and Oxford Oolite," in 1836.

The lignites of the three Portland beds, locally termed the *"dirt beds,"* are all of a tropical character; consisting of Cycadeæ and dicotyledonous plants, in a petrified or siliceous state.

Dr. Fitton has published a vertical section of these beds, and a drawing of one of the vertical trunks of the trees. The length of the latter is 23½ feet, the largest diameter being 18¾ inches. The fossil or silicified trunks of Portland, on being examined, in thin transparent slices, with the miscroscope, by Mr. Brown, were observed to possess the characters which uniformly belong to conifereus wood. The *Cycadeæ* and *Mantelliæ* are generally from nine inches to a foot in diameter, and about the same height;‡ standing erect on the spot where they once flourished, between rows of petrified fir trees.§

Mr. Brown considers the class to which the fossil plant of Portland belongs, as forming an intermediate link between the pines, or coniferous plants, and the *Zamia.*

Respecting the numerous trunks and fragments of trees in the Portland oolite, it has been remarked, that, unlike those of the tertiary period, they are never perforated by Teredo.

In the Wealden groupe, zamiæ, cycadeæ, and fruits of cycadeous plants occur with the bones of the Ignanodon, in the Isle of Wight.

WEALDEN GROUP.

Hastings Sands.—Amongst a great number of fresh-water fossils this series contains abundance of interesting lignites, which have been brought to notice by Dr. Fitton, Dr. Mantell, Messrs. Greenough, Martin, and other scientific investigators.

Among these vegetable remains occur great numbers of the singular fossil which has been named *Endogenites erosa*, a monocotyledonous tree, having a thick covering or coat of coal.

This formation includes some species of ferns, and coniferæ: some calamites, lycopodites, sphenopteris, and many species of plants, of which some have not been defined.|| The sinkings at Bexhill, in Sussex, in search of coal, at a great expense, were conducted in the beds of this formation. It is said that a kind of cannel coal, extending for a quarter of a mile in beds of from two to ten inches thick, occurs on the banks of a stream in this county.¶

According to the opinion of Dr. Mantell, the Hanoverian coal-fields are situated in deposits of the Wealden period.** Dr. Beck assigns the same period for the coal of Bornholm in Denmark.

* Coneybeare and Phillips—Geology of England, p. 172. † Geological Manual, p. 295.
‡ Strata below the chalk—Fitton, p. 249. § Medals of Creation, p. 159.
|| Dr. Mantell's Tilgate Forest, p. 54. Martin's Western Sussex, p. 41. Dr. Fitton on the strata below the chalk, p. 172. Geological Trans., Vol. I. p. 423. De la Beche—Geological Manual, p. 296.
¶ Outlines of the Geology of England, p. 137. ** Wonders of Geology, p. 688.

Fossil Forest of the Wealden Strata, as exhibited in the Isle of Wight.—Dr. Mantell's more recent description [in 1845,] of the appearance of this interesting deposit, is very graphic. Thirty-five years previously it had been described by Mr. Webster, and twenty years afterwards by Dr. Fitton, yet we read Dr. Mantell's paper with increasing interest.

Dr. Mantell observed that "the trees are lying confusedly, one upon the other, and saw no erect trunks, or any other indication that a forest had been submerged while growing in its native soil, like that of the Isle of Portland; but, on the contrary, the appearance is that presented by the rafts that float down great rivers, as for example the Mississippi. Such rafts entangle in their course the remains of animals and plants that may happen to be in the bed of the river, and at length subside and are buried in silt and sand. The fossil trees in this cliff are associated with large river shells, and with the bones of colossal land reptiles. We may therefore consider the fossil forest at Brook Point as a raft of pines which were floated down the river of the country near which the Wealden beds were deposited, and had become submerged in the delta or estuary at its mouth, burying with it the bones of reptiles and the large fresh-water mussels it had entangled in its course."

It is decided that the large trunks found in this position, are those of petrified coniferous trees, and the wood exhibits, under the microscope, the structure of the type seen in the *Auracaria* [Norfolk Island Pine,] the rows of glands or ducts being placed alternately. No traces of the foliage of these trees, nor of their fruit, with the exception of a small cone, were observed.

When lying in the sandstone, they are invariably covered with their bark, which is now in the state of lignite, varying from one to four inches in thickness, according to the magnitude of the trunk. This carbonized cortical investment is quickly removed on exposure to the action of the waves; but the ligneous structure, the woody fibre, remains.

These trees are calcareous, and not siliceous like those of Portland. They are more or less traversed by pyrites, and are from one to three feet in diameter; apparently indicating a height of forty or fifty feet when entire.*

Cretaceous and Sub-cretaceous Periods.—The Lower Green Sand and the Weald Clay, below the chalk, contain siliceous fossil decotyledonous wood at Blackdown, in Devonshire. It is perforated by some boring shell. The formation also contains cones of conifera, and ferns.

Mr. Boué states that the marls which alternate with the ferruginous and green sandstones below the chalk in the south-west of France, contain beds of lignite.†

The *Lower Green Sand* and the *Gault* contain fucoides.‡

The *Upper Green Sand*, impressions of ferns?

The *Chalk* contains several species of marine vegetables, confervæ, fucoides, naiades, and, in Scania, cycadites.§

III. *Tertiary Lignites, Plastic Clay, Fossil Plants, Fruits, and Seed Vessels.*—Those of Sheppy, Sussex, the Isle of Wight, &c. must be referred to the *Plastic Clay* formation.‖ They probably correspond, in geological age, although not in detail, with the fossil plants of the tertiary beds on the borders of the Irawadi, in Ava.

* Quarterly Journal of the Geological Society of London, May 1, 1846, p. 91.
† Annales des Sciences Nat., tom. iii. p. 300.
‡ Dr. Fitton, strata beneath the chalk, p. 351.
§ Geological Manual, de la Beche, p. 264.
‖ Dr. Macculloch on Lignites.

Fossil plants abound in the Plastic Clay of the Isle of Wight and of the Hampshire coast. In the cliffs of the latter, according to Mr. Brodie, are beds containing impressions of ferns and leaves. The fossil plants belong, in part, to the Lauraceæ and Armentaceæ; but these, as well as others which Mr. Brodie arranges among the Characea and Cryptogami, and some of which he has not yet determined the characters, are all generically distinct from any British plant, and belong to those of a warmer climate. These remains often form masses of some thickness; and from their state of preservation, must have been deposited tranquilly beneath the waters.*

In the *Upper Fresh Water Formation* of the Isle of Wight, are also fluted reeds—equisetaceæ?—and flags, and numerous impressions of leaves; sometimes accompanying imperfect or spurious coal. Wood is commonly found in the *London Clay*, perforated by the Terredo. Lignites occur, in thin beds, at Alum Bay, in the vertical strata.†

London Clay.—Of fossil seeds, seed vessels and fruits, the shores and cliffs of Sheppy present innumerable quantities, in the state of pyrites. They appear to be similar to those of tropical climates. The number of species amounts to several hundred, it is said, but Mr. Bowerbank has lately investigated these interesting remains, and the reader is referred to his beautifully illustrated work. They belong to the palm tribe, and a variety of species, known and unknown.

Lignites are seen in every part of England, where the plastic clay beds are exposed or explored. The same circumstance occurs in France—for instance, at Château Thierry, and in the Valley of Soissons, &c.‡

Among these beds of workable brown coal, enumerated in the present volume, it will be seen are the following:

Tertiary Lignite Beds, worked as Coal—Brown Coal.—England, Bovey coal; Romelia, Shores of the Black Sea; Candia coal mines; Switzerland, Zurich, Luzerne, &c.; Piedmont, brown coal with mammoth's bones; Moravia, Walchow; Lower Styria, several extensive beds worked; Hungary, abundantly worked; Northern Bohemia, mined in great abundance for iron making; Nassau, near Frankfort, for same purpose; Westphalia, Buckeberg; Western Prussia, Bonn, Cologne, extensively worked; Pomerania, abundant; Courland, do.; Livonia, do.; Wurtemburg, do.; Thuringia, do.; Saxony, do.; Hesse Cassel, do.; Suderöe Island, like true coal; Bessarabia, do.; East Moldavia, do.; Crimea, do.; France, in numerous departments, extensively worked; Australia, now much worked; China, abundant; New Zealand; North America; South America; New Granada; Chili; Peru.

Tertiary Lignites, not sufficiently abundant or concentrated to form workable coal beds.—In Antigua; east side the Andes, Chili; Egyptian and Lybian Deserts; Nubian Desert; Gulf of Suez; Basin of Paris; North of France; various departments of France; Paris Basin; Piedmont; Upper Styria; Lower Styria; Ava and Pegu; New Siberia; Lächow Islands; Virginia; New Jersey; Delaware; Scotland; England; numerous places, for which see the index.

TERTIARY COAL AND LIGNITE.

4. *Devonshire Bovey Coal Deposits, Bovey Heathfield and Bovey Tracey, England.*—Insignificant in point of mineral value as this tertiary

* Proceedings Geol. Soc. Lond. Vol. III. p. 592.
† Mantell's Medals of Creation, Vol. I. p. 86.
‡ Bulletin de la Societé Geologique de France, tome x. p. 183.

lignite formation may be, yet as it has acquired celebrity from the dissertations of many authors, and is familiar to all as representing the type of this species of fossilised vegetable matter, we should scarcely be justified in omitting to notice it here. This well known series of layers of bituminous wood, is the true brown coal, the *Braunkohlen* of the Germans, and for a long series of years was worked and employed for various economical purposes. The experiments of Mr. Hatchett on this coal, were laid before the Royal Society more than forty years ago, and Mr. Parkinson described the local characters of the formation nearly as far back. His section shows seventeen beds of brown coal, of various qualities, within the space of seventy-five feet; the entire thickness proved being one hundred and eight feet.

The area of Bovey coal appears to be about eight square miles, or 3,840 acres.

In 1815, Mr. Bakewell visited this interesting depository, and described it in 1828. At that time there were worked several irregular beds of lignite, in the open manner, like a quarry.

Dr. Wilkinson asserts that this coal consists of the broken trunks and branches of trees, which, by slow and gradual change from the vegetable character, are converted to jet or asphaltum.*

To the fibrous brown coal or bituminous wood, of Bovey, retin-asphalt is found adhering.† Similar coal, and cannel coal, occurs, in small quantity, at Bexhill and Waldron, in Sussex.

A later account of the Bovey coal workings mentions seven beds at present worked; altogether forming a continuous stratum of no less than 70 feet in thickness; dipping at a small angle.

Almost the only use for which this brown coal is now applied, is for a pottery, which stands on the spot. The imperfect combustion, the offensive smell emitted, and the large proportion of ashes, render it unavailable for general purposes, except occasionally in the cottages of the neighbouring poor. Beds of "plastic clay" and pipe clay overlay the lignites, and from 30,000 to 40,000 tons are annually shipped for the Staffordshire potteries.

Organic remains, other than vegetable, have not been discovered in the Bovey clay. We are, therefore, Mr. De la Beche observes, deprived of any aid which animal exuvia might have afforded us in referring these clays, sands, and lignites, to any particular geological date. If the woods, there imbedded, be, as has been sometimes supposed, analogous to oak and other existing trees, the Bovey beds may have been formed towards the latter part of the supracretaceous period.‡

Dr. Mantell asserts that in the bituminized wood of Bovey, in the specimens that have come under his notice, the vascular tissue, which is coniferous, is very apparent. No leaves or fruit have been found.§

Resinous Minerals in Peat and Lignite.—A mineral resin, termed retinite or retinasphalt, containing nearly equal proportions of resin and bitumen, accompanies the brown coal of Bovey.‖

For further notices of other mineral resins, amber, sheererite, terebinthine, mellite, see under the heads, Pomerania, and of those substances above mentioned.¶

Amber occurs in lignite in Pomerania, Courland, Denmark, Poland, Sax-

* Observations on Coal, Dr. Wilkinson, Mining Review, 1840.
† Mineral Topography of Great Britain, A. W. Tooke.
‡ De la Beche's Geology of Cornwall, &c.
‖ Allan's Mineralogy, p. 292.
§ The Medals of Creation, 1844, Vol. I. p. 84.
¶ Note on the analysis of the resins in turf, Annales des Mines, Vol. XVII. p. 572.

ony, Russia, Oural Mountains, Birman Empire, Siberia, Greenland, France, Scania, England, Sweden, Peru, Raucus, Messina, Wallachia, Saxony, Livonia, Lithuania, China. See under the head of Amber.

Subterraneous Forest, in the interior.—By the Sheffield Iris, of 1843, we are apprised, that for some time past a great many of the poorer classes of the inhabitants of Macclesfield and its populous vicinity, have been abundantly supplied with fuel from a portion of a subterraneous forest discovered in that vicinity. Immense quantities of large oak trees are dug up daily. A large piece of oak, squared, and otherwise bearing marks of human implements, had excited intense curiosity.

Peat in Devonshire.—A company is in operation in this county, called the British Naphtha Company. They have made arrangements with the Duchy for grants of land, for cutting peat on Dartmoor, and for a large portion of the Dartmoor Prisons, for the works. A railway of two miles is projected to the bogs where the peat is cut. Two kinds of oil are obtained from this substance, one of which is used as a substitute for camphine.

An almost inexhaustible amount of this substance exists on the lands of the Prince of Wales, on Dartmoor. Various companies were formed in 1846, and are in operation on the Moor. The naphtha company cut from fifty to sixty tons per day, in the summer of 1846. A species of manure is also made of the prepared peat. It is dried in the open air, before placing in the retorts; the coke produced is said to be of sufficient solidity for the smelting of iron ore. It is sold at the rate of 18*s.* per ton.*

V. *Peat or Turf, in ancient estimation in England.*—Before the introduction of coal into general use, we find that no slight value was attached to the depositories of peat, for the purposes of fuel, not only for the poor, but for every class of the community. The number of *turbaries* in England, prior to the resort to coal beds, was considerable; as we ascertain from the ancient surveys, grants, and valuations of the religious endowments, of which turbaries formed an essential part, throughout the country, from the eleventh to the sixteenth century.

It is obvious from these authentic records, that in those districts where wood was always scarce, the possession of turbaries was matter of no slight importance to the monasteries and religious associations of this period; and that especial care was always taken to secure to them the privileges of such appendages in convenient situations.

From the period of Domesday Book, in the individual muniments, charters, and endowments, of all times, down to the Reformation—from the *Taxatio Ecclesiastica, P. Nicolai IV., A. D.* 1291, 1302, down to the *Valor Ecclesiasticus tempore Hen. VIII. A. D.* 1534—we find minute records of the peat bogs or turbaries, comprised within the revenues of almost every monastic institution in Great Britain, and the values then respectively assigned to them.

On this subject, the present writer speaks with the confidence of one tolerably familiar with the details of that department of English history.†

We have collected many notes on the subject of peat and its peculiar fitness for many useful purposes, in various parts of this volume, but especially when treating of Ireland, to which we refer the reader. We might

* Mining Journal, May 23d, and December 19th.

† See various notes in the "Index Monasticus of the ancient Kingdom of East Anglia, and the Diocese of Norwich," by Richard C. Taylor, London, 1821.

add various other notices in relation to the turbaries of England, were it necessary.

Among the most recent of these is a communication to the British Association in 1845, by the Rev. L. Jenyns, on the Turf of the Cambridgeshire Fens. It was stated that the Cambridgeshire turf was not formed of *sphagnum*, like the peat found in many of the masses in England and Scotland, but owed its origin to decomposed aquatic plants, of various species, associated with the remains of trees. This circumstance seems to have given rise to two kinds of turf, the *upper* and *lower*. The upper turf is much more compact and heavy than the lower, and generally of a darker colour. This is the best turf for common fires, and burns to a white ash.

The lower turf is lighter, and lighter-coloured, and its texture becomes more loose and spongy the lower it is dug. This is the best for ovens, and burns to a red ash. It consists almost entirely of the bark, wood, roots and branches of former forests, above which the upper peat has been subsequently formed, and deposited in successive layers. The thickness of the whole bed is very variable, from two to ten feet.

The two sorts of turf are not always found together; the upper exists without the lower in localities in which there are no buried trees to have given rise to the latter. In some cases where the fen has been laid dry, on its surface, by drainage, the turf does no longer grow to a sufficient extent to renew the original quantity.

It is the opinion of the turf-diggers at Iselham, that formerly the peat grew about 20 inches in sixteen years—20 inches being the length of a full-sized turf when first cut.

NORFOLK AND LINCOLNSHIRE COASTS.

VI. *Past Tertiary Lignites and Submarine and Subterranean Forests of the East Coast of England.*—The author of the present volume, in an article communicated to the Geological Society, in 1825, and to the Philosophical Magazine, in 1827, gave a short account of these interesting lignite beds; more particularly referring to the northern coast of Norfolk. He endeavoured to show that the bed so distinctly exhibited at Cromer, resting, in conjunction with tertiary deposits, immediately on the surface of the chalk, was continuous to the northward, along the shore of Norfolk, and along the Wash, and the fens of Cambridgeshire and Lincolnshire, as far as the Humber, without material variation in its general level.* The author commenced tracing this lignite bed in 1814; and in 1825 had an opportunity of studying, at his leisure, and unfortunately, to his great pecuniary loss, the memorable spectacle presented by the removal of vast portions of the diluvial cliffs on the Cromer coast. Some sections of these cliffs were 250 to 300 feet perpendicular height; large masses of which, being undermined by the extraordinary tides and storms of the memorable month of February 1825, were completely swept bare to the chalk, or rather to the stumps of trees still standing rooted in the vegetable matter, abounding with animal remains, and tertiary shells occasionally intermingled, which rested upon it, and occasionally on a thin intervening bed containing tertiary fossils.†‡

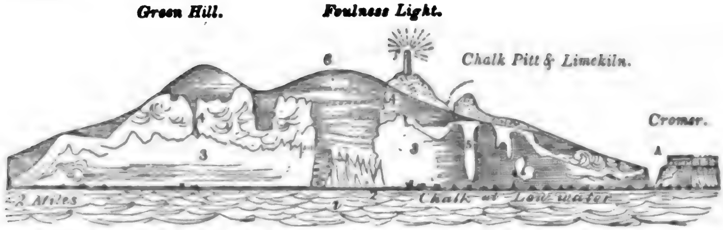
* On the chalk between Mundesley and Cromer, by R. C. Taylor, Trans. Geol. Society, read May 2d, 1823.

† Philosophical Magazine, 1827.

‡ Notice respecting the appearance of fossil timber on the Norfolk coast, by R. C. Taylor, Trans. Geol. Society of London, December 2d, 1825.

Fig. 21.

Profile of Cromer Cliff, on the coast of Norfolk, as it appeared in February, 1824, after the removal of the Face of the Cliff—showing the position of the subterranean Forest.



1. *Laminated Blue Clay with Crag Shells, resting upon Chalk, at 10 feet—seen at low water and half tide.*

2. *Bed of Wood, stumps of trees and branches, peat and woody clay, bones of deer, elephants, and other herbivorous animals; about the level of ordinary tides. Ochreous gravel and argillaceous concretions, two to four feet.*

3, 3. *Blue Clay—the lower part is occasionally stratified; it contains fragments of shells.*

4, 4. *Brown Clay, which has been much disturbed, and exhibits numerous contortions; it contains fragments of similar shells, as in the lower clay.*

5, 5. *Detached masses of Chalk—one of which is 150 feet high.*

6. *Horizontal beds of sand, on which are other beds of gravel and sand, filling gaps in the clay—no shells, or other fossils.*

The height of this cliff is about 270 feet, by admeasurement.

Profesor Phillips, in his Geology of Yorkshire, Vol. I. 1835, p. 19, conceives that the view thus taken is incorrect, in referring this lignite bed to a period anterior to what was then termed the diluvian age; "and that, in consequence, a great mistake has been committed, with respect to the antiquity of the deposits of peat and timber." The latter he considers either diluvial, or that the subterranean forests grew since the diluvian era, as regards the Yorkshire coast.*

On the Cromer coast there appeared evidence, which it was impossible to distrust, in the disastrous winter of 1824–5, that this enormous mass of diluvium had been piled upon, and had overwhelmed, the ancient forest-surface, which overspread the chalk at the level of high water; and which forest in many places was associated with a thin stratum, traceable for miles, of decidedly tertiary origin.†

We still adhere to the original views, expressed in 1827, that the geological position of this lignite bed is "between the diluvium and the crag;" and the opinion is confirmed by inspection of several unpublished detailed drawings, notes, and admeasurements, made at leisure under the most favorable circumstances for correct observation. In the case of the Cromer cliff there was no diluvium or drift below the trees.‡

Mr. Lyell, in a communication to the Geological Society, read January 1840, fully corroborates the statements of 1827, here adverted to, that the lignite underlies the drift and cliffs of mud, gravel, and sand, and overlies the chalk and crag. He considers the whole of this drift to belong either to the latest period of the newer pliocene tertiary era, or to the post tertiary period; while the lignite and fresh-water deposits beneath, containing so many mammalian remains, may be referred to the newest tertiary. Proceedings of Geological Society London, Vol. III. p. 175.

At Thornham and Brancaster Bay, the actual level of the submarine forest, visited by the present writer in 1814, is at extreme low water of spring tides,

* Phillips' Yorkshire Geology, Part I. 19.

† On the Geology of East Norfolk, by R. C. Taylor, 1827, with 11 illustrations, p. 24.

‡ Trans. Geol, Society of London, Vol. II. p. 327.

and extending beneath it. The stumps yet remain standing, often much indurated, so as to be cut with difficulty. A mass which was cut from one of these stumps was presented, by the writer, to the late James Sowerby, Esq., about the year 1814. Animal bones occur amidst the vegetable matter, at most of the points designated.

Amber is of frequent occurrence along the shores of Norfolk and Suffolk, where it is washed up by the waves, in the same manner, but in far less abundance and beauty, as the same substance is washed up along the shores of the Baltic and Sicily, from beds of lignite in tertiary strata. Amber is also found under similar circumstances on the shore of the Isle of Wight.* Jet is by no means uncommon on the eastern coasts of England. It is found in Situ, in great purity and abundance in the cliffs of alum shale on the Yorkshire coast.

The submarine forests, or some of them, are perhaps due to a later condition of things. Around the coasts of Cornwall, Devonshire, and Somersetshire, Mr. De la Beche remarks, these forests are so common that it is difficult not to find traces of them at the mouths of all the numerous valleys which open upon the sea; so that we may consider they once formed the bottoms of estuaries. None of them appear to contain animal or vegetable remains so old as the tertiary period.† The trees are of the kind indigenous to the districts in which they occur.‡

Submarine Forests and Lignite beds around the British coast.—None of these appear to be of much value as fuel or for other purposes, and we shall merely name a few of the principal points where they occur, for the sake, chiefly, of pointing out their existence.

Mr. J. Phillips describes those that occur on the Yorkshire coast, as of more recent age than the diluvium, in as much as they rest upon diluvial beds there.§

A submarine forest occurs in the Frith of Tay, and is covered by the sea about ten feet at every tide. The stumps of these trees, which are alder, birch, hazel, &c., retain their original position.||

On the west coast of Orkney, a submarine forest is covered fifteen feet at low water. A subterranean forest occurs on the Lancashire coast, north of Liverpool. It is marked upon Mr. Greenough's map, stretching upwards of sixty miles in length, and its maximum breadth more than twelve miles. Another exists below highwater mark, on the shore between the Dee and the Mersey. The trees are stated to consist of oaks of amazing size, lying in black peat. A local writer observes that no tree now grows, or can be made to thrive on the bleak and sterile tract near the vicinity of the Mersey. Traces of similar trees were frequently seen by the present writer, in 1811, in Carmarthen bay, and other points along the South Wales coast; and it was then customary to drag the large trunks from the shore, and employ them as gate posts, and for similar uses. Some of these trees are covered thirty feet deep by the spring tides.¶

The submarine forest of Stolford, in the Bristol channel, on the coast of Somersetshire, and another at Shurton bars, have been described both by Mr. Horner, and by Dr. Buckland, and Mr. Coneybeare. These authors state that they could discover no appearance to favour the notion that the

* Tooke's Mineral Topography of Great Britain, in No. IX. Mining Review, p. 45.
† De la Beche's Report on the Geology of Cornwall, &c., p. 416, 423.
‡ Mantell's Medals of Creation, p. 82.
§ Phillips's Yorkshire, part 1, 1835.
|| Dr. Fleming, in Annals of Philosophy, April, 1824.
¶ Also Phillips's Yorkshire.

ground whereon these trees grew, had subsided from a higher level to its present one beneath the waves.*

Passing to the south coast, similar appearances occur in Mount's bay, Cornwall, extending, in many instances, from beneath the sea to a considerable distance inland. At high water, the trees are covered twelve feet deep. They are also found remote from the sea, in that neighbourhood, without presenting any marks of subsidence, but are covered with beds of sand, gravel or clay.†

Between Hastings and Eastbourne, in Pevensey bay, numerous trees are occasionally exposed, whose roots are firmly fixed in soil, yet are covered ten or twelve feet by the sea at high water.‡ Mr. Webster also alludes to the submarine forest which may be seen at low water near Hastings. Numerous trunks of trees lie flat, and are accompanied by great quantities of hazel nuts.§

At distant intervals around the south-east coast, we may occasionally detect traces of this kind, and with them almost always occur bones of the elephant, deer, and other ruminants; and this brings us back again to the low coast of Cambridgeshire, Lincolnshire, and Yorkshire, and to those extensive areas before adverted to, marked upon Mr. Greenough's geological map, as "subterranean forests."

Here the principal district, including the Great Bedford Level, which alone embraces an area of 400,000 acres, and the Lincolnshire Fens, extend a hundred and fifty miles in length. Its entire area we cannot precisely state, but for a considerable distance it is from thirty to thirty-five miles broad, without including any portion of that which is supposed to be covered by the waves.

Within this ancient sylvan territory, are embraced portions of the counties of Norfolk, Suffolk, Huntingdon, Northamptonshire, Cambridgeshire, Lincolnshire, and Yorkshire. This vast area is sufficiently important and interesting to have engaged the pens of many learned men, among whom are Sir William Dugdale, Pennant, De Serra, and Vancouver.

Peat, accompanied with large trees in various stages of decay and preservation, and by bones of elk, deer, ox, and other ruminant animals, occurs in innumerable places in detached estuaries, marshes, fens and low meadows in the counties of Norfolk, Suffolk, and Cambridgeshire. In Lincolnshire it is on a much more expanded scale than in the last named counties.

Even far in the interior we have been lately informed of a deposit of this nature, near Birmingham.||

Communicating with the northern part of the great subterranean forest of Lincolnshire, &c., is the separate one which surrounds the Isle of Axholm; and which, according to the scale of Mr. Greenough's map, comprehends an area of about four hundred and fifty square miles.

The phenomena which we have thus hastily traced at so many points on the English coast, particularly on the eastern shores, are repeated on the coasts of France, the Low Countries, Germany, and other shores of northern Europe, at a level often much below that of the present ocean at high water.

With reference to this, De Serra remarks that there is an exact resemblance between maritime Flanders and the opposite coast of England. "These

* Trans. Geol. Soc. of London, Vol. I., second series, p. 310.
† Dr. Boase.
‡ Mantell's Geology of Sussex, p. 268.
§ Geol. Trans. London, Vol. II., part 1, new series.
|| Proceedings Geol. Soc., Vol. III. p. 731.

two countries are certainly coeval; and whatever proves that the first has been for many ages out of the sea, must also prove that the submarine forests we are speaking of were long before that time destroyed and buried. If is proved that in Flanders no material change has taken place for the last two thousand years.*

FOSSIL FISHES IN THE FLINTSHIRE COAL FIELD.

We have cited some interesting notices respecting the fossil vegetation of the coal period. Through the assistance of another branch of natural science, we have recently been furnished with some new and valuable illustrations relating to animal life, at the era in question. Dr. Buckland has communicated a memoir "on *Ichthyopatolites*, or petrified trackwings of ambulatory fishes, upon sandstone of the coal formation." Certain impressions having been noticed on a flagstone near the shaft of a coal pit in Flintshire, Dr. Buckland was induced to investigate them.

As these impressions presented no trace of any true foot to which long claws may have been attached, the author rejected the idea of their having been made by a reptile. They consist of curvilinear scratches, disposed symmetrically at regular intervals on each side of a level space, about two inches wide, which, in his opinion, may represent the body of a fish; to the pectoral rays of which animal he attributes the scratches. They follow one another in nearly equi-distant rows, of three scratches in a row, and at intervals of about two inches from the point of each individual scratch to the points of those next succeeding and preceding it. They are all slightly convex outwards; three on each side of the median space, or supposed place of the body of the fish. Each external scratch is about one inch and a half in length; the inner ones are about half an inch, and the middle one about an inch long. These proportions are pretty constant through a series of eight successive rows of triple impressions on the shale from the Mostyn coal pit. All the conditions noticed seem to agree with the hypothesis of their having been made by three bony processes projecting from the anterior rays of the pectoral fin of a fish.

Dr. Buckland refers to the structure of existing siluroid and lophoid fishes, and of the climbing perch, (*anabas scandens*,) and Hasser, (*doras castata*,) as bearing him out in the conclusions he has come to regarding these markings. He also refers to the observations of Prof. Deslonchamps, on the ambulatory movements under water of the common gurnard, as confirmatory of his views. He has been informed of a slab of coal sandstone bearing similar markings, in the museum of Sheffield, and remarks, that there are several fossil fishes of the carboniferous system approximating the characters of the gurnards, and capable of making such markings as those described.†

CLASSIFICATION OF FOSSIL FISHES.

The only class of fishes which existed prior to the chalk formation.	Ganoidal or ganoid, 50 genera.	From the Greek word *genos*, signifying splendour, applied to a class of fishes furnished with regular angular thick scales, externally enamelled.

*Philosophical Transactions, No. 481; also in No. 279, A. D. 1702; also notes on the Fen Country, in Richard's History of Lynn; in Pennant's History of the Fens; in Beauties of England, Vol. II. p. 294; in King's Munimenta Antiqua, Vol. I. p. 29.

† Proceedings Geol. Soc. London, Vol. IV. p. 204.

Agassiz.	Placoidian.	Fishes which were irregularly covered with large or small plates or points o enamel, like the rays or sharks.
Among the *ganoid fishes* in the iron-stone of the Scotch coal field, Lanark. The cannel coal of Lancashire. Coal shales of Staffordshire and N. Wales, Cape Breton; Richmond, Virginia.		*Palœoniscus*—a small fish. Coal shales of Autun, France. *Megalicthys*, from *megas*, great, and *icthys*, a fish. This fish is supposed to have been near sixty feet long. Found with palœoniscus. *Gyracanthus*, *gyros*, (round,) *acanthus*, (a spine or thorn;) like the dog-fish, it was furnished with elevating dorsal rays, which served to raise the back fin.

RAILROADS OF GREAT BRITAIN.

	Years.	Opened in each year.	Aggregate miles completed.	No. of Passengers conveyed.
In England, completed,	1830		30	
	1840		1300	12,000,000
	1843		1800	26,500,000
	1844	195½		
	1845	250	1900	30,000,000
	1846	650		

The editor of the Mining Journal, November and December, 1846, stated that there were then actually employed in the construction of these railroads, two hundred thousand men, annually. It is estimated that each mile of railroad would require seven hundred tons of malleable and cast iron, equal to eight hundred and twenty tons of pig iron; and that to complete twenty-four hundred miles of railroad, two millions of tons of pig iron would be required. The sum of money weekly paid in these labourers' wages, was £260,000=$1,258,400.

In the Companion to the British Almanac, for 1847, is the following statement of the railway results of the session of 1846:

Lengths of new lines authorized, about		4790 miles.
Estimated cost, as indicated by the share capital, and the estimate of expenses, laid before Parliament,	£91,165,550	
Power to borrow one-third more than the capital,	30,388,516	
Aggregate,		£121,554,066

Statistical statement of the number of railroads authorized in the United Kingdom, in three years, ending January 1, 1847.

	Miles.	Average cost per mile.
Parliamentary Session of 1844,	819	£19,148
" " 1845,	2860	20,438
" " 1846,	4705	25,685
Total in three years,	8384	

The stock and loans authorized for new railroads by Parliament, in the session of 1846, was £108,979,985.

Aggregate of capital and loans authorized for that purpose in the three years, from 1844 to 1846, £194,983,767=$943,800,000 U. S.

Comparative cost of Railroads, in various countries, per English mile.

		Miles.	Average cost per mile.		
Cost of railroads in	Belgium,	386¼	£16,600	=	$80,344
" "	United States,	4865½	5,564	=	26,932
" "	France,	4164	21,617	=	104,626
" "	Great Britain 3 years,	8384	23,390	=	113,207
" "	Do. 47 railroads,	1862	36,380	=	176,080
" "	England, average cost of railroads completed up to 1846,	1900	34,710	=	168,000
" "	Ireland,	89	14,568	=	70,509
" "	Holland,	53	5,000	=	25,000
Prussia, av'ge cost of 600 miles completed,		701	9,400	=	45,496
Germanic system of railroad lines,		7600	10,000	=	48,400
Average cost of those already constructed,			8,000	=	38,720
Denmark,		66	7,880		
Italy,		140	16,600		
Russia,		32	11,750		

Railroad Expenditure in Great Britain.

By a speech made in Parliament at the close of 1847, it appears that the country had already expended, in seven years, in the construction of railroads, capital to the following amount:

In 1841	£1,407,000	1845	£14,100,000		
1842	2,980,000	1846	36,475,000		
1843	4,435,000	1847	65,000,000	first half	25,700,000
1844	6,100,000			second half,	39,300,000

In the seven years, from 1841 to 1847 inclusive, an actual outlay of £91,197,000 sterling, or $441,393,000 United States currency.

Ships and Railways.

The new railways communicating with the coal-fields in the interior of England, will, it is thought, have an important influence on the prices of coal in London. We observe that Mr. Mahon, in giving evidence before a Railway Committee in Parliament, stated that he had had the management of coal mines in Derbyshire for twenty years past; that the coal-fields of Clay Cross, Wingerfield, and Staley, were capable of almost unlimited supply; and that he believed these coals were quite equal to the Durham. These coals could be delivered in London, by the proposed railroads, at 14*s.* 10*d.* per ton, and Erewash coals as low as 10*s.* 6*d.**

Upon this very momentous question we observe some apposite information in a pamphlet, published in 1846, entitled "Ships and Railways." The writer observes that the central coal-fields of England which, although abounding in coal, and geologically more accessible than those of the north, have been hitherto kept out of the market, except for local supplies, by their distance from convenient shipping ports. This obstruction to general competition, which has heretofore given to the northern coal trade an almost exclusive monopoly, and the consequent splendid commercial marine attached to it, will be greatly reduced, if not entirely removed, by the railroad system recently adopted throughout England, by means of which coal will be transported to London and distributed to all the towns of the interior, at

* Mining Journal, 19th July, 1845.

diminished cost. The respective mean distances of these coal-fields from London are as follows:

IX.	Warwickshire coal-field,	100	miles.
XI.	South Staffordshire, Wallsall,	120	"
X.	Leicestershire, Ashby de la Zouch,	120	"
XX.	Derbyshire and Yorkshire, { Alfreton,	140	"
	Chesterfield,	150	"
XL.	South Wales, at Merthyr Tydvil,	175	"
XVIII.	Lancashire, Stockport,	180	"
XXV.	Great northern coal-field, { Newcastle,	280	"
	Durham,	255	"
III.	Forest of Dean,	120	"
XII.	Coalbrook Dale,	130	"
V.	Bewdley and Billingsley,	145	"
XIV.	North Staffordshire or Pottery, Shrewsbury,	155	"

The cost of coal at the pit's mouth, in 1846, in Durham and Northumberland, 4s 9d. to 5s. per ton. Do. Midland counties of Lancashire, Staffordshire, Yorkshire, Derbyshire, and a portion of South Wales, 3s. to 3s. 6d.

It is stated that coals can be delivered from the interior much cheaper by railroads than in ships by sea. On some of the great lines of railway coals are carried at 1½d. per ton per mile—on others at 1d.—on some ⅝d. ½d. and even as low as ¼d. per ton per mile.

The average expense, to ships from the Tyne to London, is 5s. 8d., and including interest of capital, 7s. to 7s. 6d. per ton, lighterage, 2s. 7½d. But the competition most dreaded between the shipping and the railway interests, is, as may be inferred, not so much with the great northern collieries, as with those being opened in Derbyshire, Warwickshire, and other Midland county coal-fields.

The year 1846 was one of great depression in the northern coal trade, and the best Wall's End were selling there at 20s. 6d. per Newcastle chaldron of 2 tons 13 cwt. free on ship-board—7s. 8d. per ton.

Iron Manufactory in Great Britain, exclusive of Ireland.—Compiled from various sources.

Years.	Furnaces in blast.	Furnaces out of blast.	Total.	Annual make of cast iron in tons.	Year.	Furnaces in blast.	Furnaces out of blast.	Total.	Annual make of cast iron in tons.
1710	59			17,350	1835	360			1,000,000
1788				61,300	1836				1,200,000
1796	121			125,079	1839	379	50	429	1,343,000
1802	168			170,000	1840	384	88	492	1,396,400
1806	167	60	227	258,206	1841	350	177	527	1,387,551
1818				300,000	1842	339	190	529	1,347,790
1820	170			400,000	1843				1,215,000
1823	237		237	452,066	1844				1,575,260
1826	280	25	305	600,000	1845				2,200,000
1830	315		333	678,417	1816				2,214,000

Consumption of Coals.—Mr. Jessup estimated that in the smelting of the 1,396,400 tons of iron in 1840, the quantity of coals consumed was 4,877,000 tons.

Exportation of Iron and Steel from Great Britain, viz. England, Wales, and Scotland.

	Tons.	Total tons.	Declared value.	Total value.
In 1827, iron of every description,		92,313	£1,215,561	*
In 1843, - - -			2,590,833	
In 1814, - -			3,193,368	
In 1845, Pig, - -	77,362	351,629	3,501,895	£6,589,856
" Bar, - -	153,813			
All other kinds, - -	120,954			
Hardware, cutlery, and machinery,			3,087,961	

Comparative statement of the commercial value and amount of the *Coal and Iron* produced in England, and in other countries.

The quantity of coal which is raised in the United Kingdom is at least ten times that of France.

The amount of iron annually made in Great Britain, as compared with France, is as 4 to 1. That of coal consumed in iron works alone, in the former, is more than double that of all the coal raised in France.

In England, the average quantity of coal annually raised by each person, is 253 tons. In France, only 116, tons.

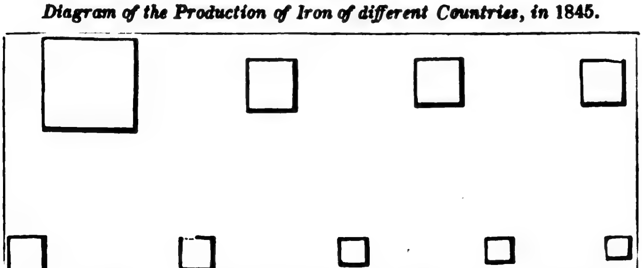
In France 47,800 persons were employed in producing one fourth the quantity of iron made in England by 42,400. The prices of iron are there from 100 to 250 per cent. higher than in Great Britain, while nearly 20,000 tons of English bar iron were received by her. France, with her 88 coal and lignite basins, has not yet rendered herself independent of foreign importations of coal. Her foreign supplies are nearly equal to half the quantity which she raises within her own limits,† but her facilities of production are increasing with great rapidity.

Annual Production of Pig and Cast Iron in Great Britain, France, and other European States, and the U. S. of America.

Years.	G. Britain. Tons.	France. Tons.	Belgium. Tons.	Zollverein. Tons.	U. States. T's. Pigs.	Austria. Tons.	Sweden. Tons.	Russia. Tons.
1841	1,327,612	377,142	90,000		287,000	151,000	90,000	300,000
1842	1,347,790	399,456	121,000	108,440		180,000		
1843	1,215,000	416,377		210,000				320,000
1844	1,575,260	421,388	153,791	250,000	486,000		100,000	380,000
1845	2,200,000	448,900	150,000	300,000	502,000	190,000	145,000	400,000

Fig. 22.

Diagram of the Production of Iron of different Countries, in 1845.



* Mr. Porter's paper addressed to the British Association, 1846

† Mining Journal, Jan. 18, 1845.

Aggregate Manufacture of Iron and Steel in Europe.

In a report to the minister of agriculture and commerce of France, by M. Goldenberg, in 1845, is an estimate of the quantity of iron made by the principal producing European States, at 2,700,000 tons. This aggregate is known to be below the actual result, and we therefore have prepared anew the following summary.

Nations.	Iron made in the following years. 1844.	1845.	1846.	Steel made in 1844.*
	Tons.	Tons.	Tons.	Tons.
Great Britain, - -	1,575,260	2,200,000	2,214,000	21,000
France, - -	427,100	438,900		7,900†
Russia, - - -	320,000			3,200
Zollverein, - -		300,000		20,500
Belgium, - - -	153,791			
Austria, - -	151,000	190,000		
Sweden, - - -	100,000	140,000	145,000	2,900
Other parts of Europe,				500
Total,				56,000

There are some obvious discrepancies between this and the preceding table, which we do not undertake to explain.

Merchant Marine of Great Britain and the United States.

Although, strictly speaking, the following tables are not essential to the plan of the present work, we give them insertion, with as much brevity as practicable, for the sake of showing the magnitude of the coasting trade, of which, as relates to Great Britain, coal forms the principal item. This statement includes the entrances and clearances, both in the foreign and coasting trade of each country, the number and tonnage of sailing vessels and steam vessels, belonging to the ports of each country, and the number of vessels built, periodically.

Great Britain and Ireland.‡	1843.		1844.		1815	
Vessels in Commerce and Fisheries.	Ves'ls.	Tonnage, entries.	Ves'ls.	Tonnage, entries.	Ves'ls enter'd.	Tonnage.
British vessels employed in the foreign and colonial trade, - - } entered inward,	19,674	3,655,230	19,564	3,925,422	19,502	4,185,273
In the coasting trade, do.	127,840	10,785,450	131,461	10,822,176	144,908	12,485,854
Exclusive of steam vessels, - -	147,514	14,440,680	151,025	14,747,598	164,410	16,671,127
British vessels employed in the foreign trade, } cleared outward,	21,402	3,691,574	21,980	3,753,369	19,054	4,134,387
In the coasting trade, do.	141,010	11,302,657	141,697	11,321,138	158,454	13.114,104
Exclusive of steam vessels, - -	162,412	14,994,231	163,677	15.074,507	177,508	17,248,491
	Dec. 31, 1844.		Dec. 31. 1845.			
Number of steam and sailing vessels built and registered annually,§	1,142	151,639	853	123,230		
Sailing vessels belonging to Br. ports,	3		29,653	3,433,272		
Steam " " "			1,001	129,693		

* Mouvement Commercial, 1845, No. 241, p. 165.

† "Les despotes, de l'angleterre et de l'allemagne ont rompu tout commerce avec nous. Eh bien, *faisons notre acier*." Address of the Committee of Public Safety to the iron manufacturers, in the first revolution of France.

‡ Parliamentary Returns.

§ British Almanac and Companion, 1846-7.

*United States of America.**	1844.		1845.		1846-7.	
	Vess'ls.	Tonnage, entries.	Vess'ls.	Tonnage, entries.	Vessels enter'd.	Tonnage
American vessels, entered inward,	8 148	1,977,438	8,133	2,035,486		2,101,359
" cleared outward,	8,343	2,010,924	8,197	2,053,977	8,102	2,202,393
Of these there were employed in the coasting trade and fisheries,		1,173,537		1,282,344		
		Tonnage owned.		Tonnage owned.		Tonnage owned.
Tonnage owned in the U. S. registered, enrolled, and licensed—permanent and temporary—including steam vessels in the coasting trade and fisheries, - - -	†	2,280,095		2,417,012	19,666	2,416,999
Vessels built in the United States, in 1845 and 1846, - - - -			1,088	146,018	1,430	188,202
Sailing vessels, in commerce and fisheries, - - - -	13,679	604,637	16,000	595,900	13,782	839,608

In proof of the great advance in the commerce of Great Britain, we add from the official returns a statement of the comparative value of the imports and exports in the years 1803 and 1845:

	1803.	1845.
Imports,	£26,822,696	£85,281,958
Exports,	28,541,405	150,877,902
	55,364,101	236,159,860

Being an increase of 329 per cent. in 42 years.

Steam Vessels of the three principal Maritime nations in the world; in commission and building, in 1845–6:

Countries.	Merchant Marine and Packet Service.			War Steamers.			
	No.	Tonnage.	Horse power.	No.	Guns.	Horse power.	
Great Britain,	916	118,772		179	688		
Her Colonies,	81	10,921					
United States,	1,800	344,797		13			probably a considerably larger number of merchant steamers & p'kets.
France,	259		13,250	68	436	14,570	

Steam ships of the Peninsula and Oriental Steam Navigation Company, [*England.*]

	Ships.	Tons.	Horse-power.
In service in 1846,	21	21,800	7,310
Building,	6	6,500	2,600
Total,	27	28,300	9,910

This private company, formed but a few years since, "is in possession of a fleet of steamers far superior to the Royal steam navy of the largest maritime power of continental Europe, and is already paying large dividends."‡

* Hunt's Merchants' Magazine, Feb. 1846, and other published sources.
† American Almanac, 1847.
‡ Mining Journal, 12th Dec., 1846.

Comparative view of the *commercial* importance of the principal maritime nations of Europe, and in the United States.*

Nations.	No. of vessels in com'erce and fisheries.	Tonnage in 1846.	No. of guns to each 100,000 tons of commerce.	Tonnage in 1845.	Av'age measurement. Tons in 1845.	Tons in 1827.	Men in 1845.
1. Great Britain and her Colonies,	23,898	3,007,581	588	3,637,231	128	111	216,350
2. U. States of America,	19,666	2,417,012	97				
3. France,† - -	13,782	839,608	1,063		44	48	
4. Russia, - -		239,000	2,466				
5. Two Sicilies, -	9,174	213,198	158				
6. Sweden and Norway,	5,450	471,772	224				
7. Holland, - -	1,528	241,676	683				
8. Turkey, - -	2,220	182,000	1,461				
Remaining European powers, -	16,235	689,844					

We add to the foregoing table a comparative view of the *Naval Forces* of the same nations, in 1846.*

Nations.	Vessels in commission, in ordinary, building, &c. Vessels of all classes.	Guns.	Number of men.	Number of War Steamers.
1. Great Britain, -	636	17,681	40,000	141 ‡
2. U. States of America,	77	2,345	8,724	5 §
3. France, - - -	346	8,928	27,554	68
4. Russia, - -	179	5,896	59,000	32
5. Two Sicilies, - -	17	338		
6. Sweden and Norway,	380	1,856		2
7. Holland, - - -	134	1,646		4
8. Turkey, - -	66	2,660	26,820	9

Relative maritime importance of the three principal navies, of the world, England, France, and the United States of America.

M. Dupin has recently published an elaborate essay under this title; we have brought down the statement to 1846.

"These three great nations share among them the dominion of the seas; they alone, carry on more maritime commerce than all the others put together. The population under the control of these three countries was as follows, in 1845:

British Empire,	125,000,000 persons.	1846—25,000,000 in Gr. Br.
Kingdom of France,	35,400,000 "	
Repub. of the U. States,	20,000,000 "	
	180,400,000	

These three great powers, according to Baron Dupin, extend over one fifth of the population of the globe.

* From the American Almanac for 1847, p. 131.
† Report of the Société Maritime, 1846.
‡ Exclusive of 134 vessels, having 310 guns, chiefly mail and Indian steamers.
§ Exclusive of 13 sailing and 8 steamers, having 61 guns, and revenue vessels.

Their relative proportion of commerce—viz: their aggregate of imports and exports, in 1840 and 1845, stood thus:

	1840.	1845.
British Empire,	3,415 million francs	
Kingdom of France,	2,063 " "	2,427 millions.
Republic of the U. States,	1,224 " "	1,201 "
1,577 millions in 1847.		
Total,	6,702 millions.	

The comparative commercial marine of these three great powers, is:

	Tonnage.
Great Britain and plantations, in 1845,	3,637,231
United States, "	2,417,002
France, "	839,608

Arrivals and departures of national ships employed in foreign commerce:

	1846.	1847.
Great Britain,	6,591,738 tons	
United States,	3,274,242 "	4,303,752
France,	1,416,329 "	
	11,282,309	

New vessels built annually, including steamers for the support and increase of the commercial marine of the three great powers:

	Tonnage, 1846.	1847
Great Britain,	131,568	
United States,	88,202	243,732
France,	53,319	

SCOTLAND.

Coal Area.—Among the recent works on the Geology of Scotland, may be named that of Mr. James Nicol. This author estimates the proportional superficial extent of the coal measures in this country at one seventeenth of the whole area, and as being greater in actual extent than that of all the coal-fields of France together.* With relation to the first portion of this paragraph, we observe that it nearly accords with our own calculation, viz. one eighteenth part of all Scotland and its islands. In relation to comparative area, our tables show that Scotland possesses a coal area of 1720 square miles, and France has 1719 square miles; being the 118th part of the whole area of that country.

* Guide to the Geology of Scotland, Nicol, 1844. Also Quarterly Journal of the Geol. Society of London, No. I. p. 139.

HISTORY OF SCOTCH COAL.

The first mention of coal in Scotland is in 1291, when the privilege of digging coal in the county of Fife was granted to the Abbey of Dunfermline.*

Æneas Sylvius, afterwards Pope Pius II., relates that "he saw in Scotland the poor people, who in rags begged at the churches, receive, for alms, pieces of black stone, with which they went away contented. This species of stone they burn in place of wood, of which their country is destitute."

But in England it must have been known some centuries earlier; as is shown by a grant of some lands by the Abbey of Peterborough, dated A. D. 853.† It was therefore used in Saxon times; and, indeed, from circumstances mentioned by antiquaries, there is some reason to believe that the pit coal of Britain was known to, and occasionally used by, the Romans. The author of the History of Fossil Fuel has collected a great many notes, relative to the early notices of this mineral in Britain, and to these we would refer the reader.‡ However, this fact we learn, that sea-coal or pit-coal, did not come into much use until the fourteenth and fifteenth centuries, and that it was not employed as fuel in the manufacture of iron until the eighteenth century.

As regards quality, the Scotch coals are mostly of the kind termed open-burning and dry, in opposition to caking coals. According to McCulloch, they do not last so long as those from Newcastle. They yield less heat, do not run together in burning, and usually leave a considerable quantity of *white* ashes; in these respects resembling several of the Yorkshire sorts.§

Few coals are really without sulphur, or iron pyrites; a most injurious accompaniment, either in domestic economy, or when used in iron-making. The prevalence of such obnoxious admixtures in mineral coal, is obviously so objectionable, that no advice need be given as to the rejection of such coals as contain a superabundance of them, or of any earthy substance in excess.

SCOTCH COAL TRADE.

The bulk of the coal mined in Scotland is applied to home consumption and iron making. On account of its position, it is but little known in the London market, and the quantity received there is decreasing, as may be seen in the table below.

A larger quantity was annually shipped to Dublin. We have no specified returns at hand, save that in 1828 it amounted to 135,064 tons. In that year, the Scotch coal trade appears to have been thus apportioned:

	Tons.
Shipped and sent coastwise to various parts of Great Britain,	233,338
To Ireland,	135,064
British Colonies,	18,635
Other foreign countries,	13,305
Exported,	500,342
Imported,	247,489

Scotch coals shipped coastwise or exported.—In 1828, 500,342 tons. In 1836, 624,308 tons. In 1837, 626,532 tons.

* Arnot's History of Edinburgh.
† Whitaker's History of Manchester.
‡ History of Fossil Fuel, p. 309.
§ Ibid.

Statement of Scotch coal shipped to the Port of London.

	Years.	Tons.	Years	Tons.
Average of four years, ending	1831	22,330	1837	18,735
Year	1834	39,487	1839	29,276
Average of four years, ending in	1835	36,290	1840	31,200
Year	1835	40,955	1842	19,484
1	1836	22,674	1843	12,108

Prices of best Scotch coal at the port or place of Production.

Years.	Per Newcastle chaldron.	Per Ton.	United States.
	s d.	s. d.	Dollars.
1789	18 11	7 2	$1.73
1839*.	St. Davids,	10 0	2.42
	Charleston,	11 0	2.66
	Kincardine, Alloa & Clackmannan,	8 6	2.05

Table of shipments of coal to Foreign parts from the eight principal ports from the official returns.

Ports.	1844	1845	Ports.	1844	1845
	Tons.	Tons.		Tons.	Tons.
Borrowstounness,	93,265	73,656	Alloa,	20,996	25,306
Irvine,	46,415	35,403	Greenock,	17,818	23,318
Kircaldy,	30,119	20,779	Leith,	15,666	9,721
Glasgow,	23,017	29,376	Grangemouth,	10,612	11,974

The following table shows the aggregate of coal annually exported from Scotland to foreign parts:

Years.	Tons.	Years.	Tons.
1828	31,940	1838	101,303
1833	74,932	1839	130,565
1834	69,173	1840	158,892
1835	71,671	1841	215,309
1836	76,232	1844	257,908
1837	78,852	1845	229,513

XXVII. SOUTHERN COAL REGION, DUMFRIESHIRE.

A belt of carboniferous strata stretches in an east and west direction from the Northumberland coal-field, No. XXVII. A, nearly to the mouth of the Nith river, below Dumfries, and re-appears in an isolated patch, on the opposite headland at Kirkbean.

The *Canobie* coal-field is within the range of the foregoing, passed through by the Carlisle railroad.

According to recent evidence, before a Parliamentary committee, this is a small coal-field, only three miles by two, but contains fifty-five feet of workable coal, in ten seams. It has heretofore been but slightly worked; but the present worked seams can be made available for an annual supply

* "Present state of the Coal Trade," 1839.

for 70 years. It is further estimated, that on the same scale of supply the whole series will not be exhausted for two hundred years. The present price of coal at the pit's mouth is 5*s.* 4*d.*=$1.29 per ton.*

Sanquahar, in Dumfrieshire.—This appears to be a small detached coal area in the county of Dumfries, bordering on Ayrshire. Valuable coal mines exist in this parish.

LANARKSHIRE OR CENTRAL COAL-FIELD.

Among the many subdivisions into which the great Scotch coal district is partitioned, that of Lanarkshire is perhaps the most extensive, comprehending about three hundred square miles in that county; and if we take the whole area between Edinburgh and Glasgow, extending westward down the Clyde, the space is equivalent to six hundred and fifty square miles.

A contributor to the Mining Journal further subdivides the Lanark area, and describes it as a basin of one hundred and forty square miles, terminating north at Glasgow. This basin contains the "Upper coal series of Lanarkshire."

It comprises from twenty to thirty seams of coal, of various individual thickness, five or six only of which are usually worked in any one pit or colliery. These latter generally measure from twenty to twenty-one feet, in the aggregate.

In quality they are represented as commonly uniform. None of them are caking coals; but in certain spots they are seen to be much depreciated by he traversing of a culmstone bed.†

In 1845, there were 2,047,000 tons of coal raised in Lanarkshire. The distribution of this quantity is accounted for by Dr. A. Watt, as follows:

	Tons.
In the iron-works, - - - - - -	1,000,000
Consumed in Glasgow, - - - - -	700,000
Shipped at the harbour, - - - - -	120,000
Sent to the river Clyde by canal, - - -	70,000
Sent to Greenock by railway - - -	29,000
Consumed by steam-vessels on the Clyde, -	64,000
Consumed in the country around, - -	43,000
Otherwise disposed of, - - - - -	21,000
Total,	2,047,000‡

According to Mr. Jameson, the variety called columnar glanee coal, burning without flame or smoke, forms a bed, several feet thick, in the coal-field of Sanquahar, in Dumfrieshire, already noticed. At Saltcoats, in Ayrshire, it occurs not only in beds, in that part of the coal district, with the usual accompaniments, but also imbedded in greenstone. Near Cumnock, also in the Ayrshire region, is a bed of columnar glance coal, from three to six feet thick; in which the columns are *arranged in rows like basalt*, and intermixed with graphite.§

Dumfermline District, included in XXXV.—Celebrated for splint coal, which is highly estimated for steam purposes. It is worked extensively, and is generally about three feet nine inches thick.||

* Mining Journal, May 23d, 1846.
† Mining Journal, Vol. XII. p. 293, from the Glasgow Practical Mechanic.
‡ Report to the British Association, in 1845.
§ Jameson's Dumfrieshire.
|| Dunn, p. 123.

Clackmannanshire Coal-field, near Stirling, included in XXXV.—See various diagrams of this basin in Ure's Dictionary, p. 966.*

An interesting section (fig. 805) occurs in that work, on the authority of Mr. Bald, of this main coal basin, [also fig. 806.] In this remarkable coal-field, which has been accurately explored by pitting and boring, to the depth of 703 feet, there are no fewer than 142 beds, or distinct strata, of coal, shale and sandstone. Among these are twenty-four beds of coal, constituting an aggregate thickness of fifty-nine feet four inches; the thinnest seam of coal being two inches, and the thickest nine feet.† This district is further subdivided, according to Mr. Bald, into three fields. Their contents are as follows:

	Thickness of formation in yards.	Thickness of coal in feet.
The North Field, - -	238	46
The Middle Field, - -	236	41
The South Field, - -	193	34

In point of quality, these coals are all of the open burning kind.

GREAT SOUTHERN COAL AREA.

XXIX. BASIN OF THE CLYDE AND GLASGOW REGION.

We have seen a statement in which it appears that the Clyde Valley coal-field contains, in all, eighty-four coal seams, the thickest of which is nine feet. The upper series of carboniferous strata, is more valuable for its singular abundance of good clay iron-stone; no less than sixty-four beds or layers, occur, and one three feet seam of coal, within the depth of more than one hundred and twenty fathoms, ere reaching the main, or Hurlet coal seam, five to eight feet thick.

Such a section, it has been remarked, may well set the fears of the people of Scotland at rest, as to the termination of a supply of this invaluable mineral. No district, perhaps, is so stored with it as the West of Scotland.‡ Here occur splint, cannel, and other coals, and the famous "Black band iron-stone," twenty inches thick.

Dr. Millar states that the iron-stone of the Scottish coal-fields, "has given birth to numerous manufactures; and, in particular, to the operations of the smelting furnace, in the reduction of the ores of iron, as well as of converting that important metal into the multifarious utensils and articles of machinery, for which the peculiar properties which it possesses, in its various states of combination, render it eminently useful. To verify this remark, the iron-works of Shotts, Cleland, Airdrie, and Clyde, and particularly the grand establishment at Carron, need only be mentioned."

The cheap and abundant supply of coal has been the principal cause of the extraordinary progress made by Glasgow in manufacturing industry; and, more recently, the discovery of the peculiarly valuable carboniferous iron-stone, provincially termed *Black band,* has made Lanarkshire one of the principal seats of the British iron trade. In 1834, about 48,000 tons of iron were produced by the different iron-works in this county; and so astonishing has been the subsequent progress of the trade, that in 1840,

* Ure's Dictionary, art. Pit Coal, p. 966, fig. 801—805.
† Wernerian Society's Memoirs, Vol. III. p. 133.
‡ Glasgow Practical Mechanic.

about 210,000 tons of iron were smelted, and various new furnaces were then, also, in the course of being erected.*

The increased requirements for the use of so many new iron-works, of course, occasioned an enlarged demand for coal. This circumstance will account for the reduced amount of exports.

For a long time the bland band ore was thought to be confined to the district of Airdrie, but it is now found to accompany the coal throughout vast extents of the neighbouring counties, and may be termed inexhaustible. The market price of it, when calcined, is 8*s.* or 10*s.* per ton.†

There is another cause, besides the discovery of the black band iron ore, which has occasioned the increased make of iron in Scotland. We refer to the introduction of the hot-air blast.

At a complimentary entertainment given, February, 1845, at Glasgow to Mr. Neilson, the inventor of the hot blast process, it was stated that that invention had increased the consumption of coal in Scotland to an enormous extent.

Previously to the employment of hot blast, the quantity of coal used in the manufacture of iron in that country was about 300,000 tons a year. In 1845, above 1,000,000 tons were used; and this million tons produced ten times the quantity of iron that the 300,000 tons did.

In 1828, the iron made in Scotland amounted to nearly 40,000 tons annually. In 1844, it amounted to 400,000 tons annually. To produce the latter quantity of iron, on the old system, would have required 2,000,000 tons of coal.

Another remarkable effect has been produced, in the reduction of the price of iron, through the same instrumentality.

Cold Blast.—The average price of pig iron in Scotland, for the ten years, from 1821 to 1830, inclusive, £7 2*s.* 6*d.*=$35.09 per ton.

Hot Blast.—Average of the last ten years, from 1835 to 1844, inclusive, £3 17*s.* 6*d.* = $18.15 per ton. Making a saving to the country, during the latter period, of no less than £3,250,000 = $15,730,000, on the cost price of iron.‡

The Victoria colliery, near Nitshill, in Glasgow, is the deepest in Scotland, being 173 fathoms, or 1038 feet in depth. Two explosions of fire-damp occurred in this pit, November and December, 1845. Fortunately, no person was killed, but the coal was ignited.§

XXX. THE GREAT COAL REGION OF SOUTH SCOTLAND.

This is an extremely irregular area, whose absolute admeasurement it is not easy to define, being made up of a number of coal areas, intersected by subordinate formations, which rise from beneath the true coal formation. It includes the whole of the south side of Fifeshire, a large portion of Lanarkshire, portions of Ayrshire and Renfrewshire, East-Lothian, Perth, Stirling, Dumbarton, Linlithgow, and Haddington.

Instead of being one continuous district, it is so intersected by older interposing rocks, that it more properly may be affirmed to consist of about twenty insulated areas. Probably the united area comprises about 1650 square miles, equal to 1,056,000 acres. Mr. Craig, in a communication to the British Association, assumes that the coal formations of west Scotland occupy a space of three thousand square miles, including in that estimate

* McCulloch's Gazetteer.
† Dunn's History of the Coal Trade, p. 126.
‡ Mining Journal, Feb. 8th and 15th, 1845.
§ Ibid. Dec. 1845.

the new red sandstone at the upper part, and the limestone group at the base of the whole series.* In the main coal-field, pits have been sunk to the depth of seven hundred and four feet, passing through one hundred and forty-two alternations of strata, including twenty-four seams of coal, amounting together to fifty-nine feet. In quality, it is all of the *open burning* kind, having little or no tendency to cake.†

The total thickness of the coal measures here is from 6000 to 6300 feet. There are between fifty and sixty coal seams exceeding one foot, and extending up to thirteen feet in thickness. The coal strata, from six inches upwards, amount to a total of two hundred and four feet; a much greater thickness than occurs in the English coal-fields. There are thirty-six cubic yards of Scotch coal in thirty-two tons weight.

In the Johnstone Coal-field, near Paisley, the coal measures are covered by a hundred feet of greenstone. Here are united at one spot no less than ten beds of coal, whose aggregate thickness amounts to *one hundred feet;* a solid mass of combustible matter, in the form of coal, which, as remarked by Mr. Bald, has probably no parallel in the world. The Hurlet mine has been worked for two or three centuries. Here the coal is covered with alum shale, the quantity of which is so great, that a large alum work has been for many years established.

At the Quarrelton Coal-field, in Renfrewshire, the same mass of coal occurs, from fifty to sixty feet thick in some parts, being composed of five distinct seams, separated by thin strata of shale and ironstone. This great thickness appears to have been produced by a disturbance of the strata, which has caused the series to break and overlap or *double over each other*, as shown by fig. 808, Ure's Dictionary. This disturbing cause was, in all probability, an irruption or protrusion of the basalt which covers and underlies the coal.‡

Renfrewshire Coal-field, [*included in No.* XXX.]—This region is both singular and interesting. The highest bed consists of above one hundred feet thick of overlying trap or greenstone unconformable to the coal strata. Passing through some soft sandstones and slate-clay, we arrive at ten seams of coal, which are separated only by thin seams of clay, and which have an aggregate thickness of no less than one hundred feet of coal, as before stated.

Quarrelton.—The whole extent of this remarkable mass of coal is, according to Mr. Dunn, but one mile long and three-quarters of a mile wide at Quarrelton. It is every where covered above the sandstone and shale, by a hard blue whinstone, containing nodules of limestone; then occur fifty or sixty feet of coal, in five beds, with as many seams of ironstone, and succeeded again by similar whinstone.

XXXI. MID-LOTHIAN COAL-FIELD.

The boundaries of the coal-fields around Edinburgh being somewhat intricate, we can scarcely attempt to define the area here denominated the Mid-Lothian coal-field. We think it very probable some of the notes relating to No. XXXII. are in part applicable to this, and are included in Mr. Milne's calculations.

It is here observable that the mountain limestone, so largely developed in the south, and forming the outer boundaries of the English, Welch, and Irish coal-fields, exists only to a very limited extent in the geology of Scotland.

* Athenæum, 184. † History of Fossil Fuel, p. 152.

‡ McCulloch's Statistics of the British Empire, Vol. I., p. 274; also, the section No. 808, in Dr. Ure's Dictionary of Science and Manufactures, p. 968.

The Mid-Lothian coal-field contains the "edge seams," twenty-four in number, constituting no less than ninety-four feet of coal. They are comprised within a thickness of 724 fathoms, = 4344 feet; and forty fathoms below these, lies the encrinal limestone of Burdie House, &c. These coals are of great variety in point of quality. The jewel coal ranks highest as a house coal. It is a hard, pure splint, and leaves very little residuum.

During the year 1843 there were exported to foreign countries, from the port of Leith, bituminous coal of the value of £58,160.

It was in this district, according to Mr. Dunn, "that the system originated of employing women to carry coals upon their backs out of the mines, and which was in full practice at the time that Lord Ashley's bill took effect, for their exclusion. To such an extent was this custom carried, that the Edmonstone colliery used to employ one hundred and forty or one hundred and fifty female bearers, even where the pits were seventy fathoms (four hundred and twenty feet) deep, and the coal nearly flat. The mode of descending the said pits was by a single chain made of half-inch iron, which often broke; and the working of which was most appalling to witness, or to trust life upon. The ordinary load for one of these females was *two hundred and thirty pounds*, carried in a coarse basket placed upon their backs, and having a strap round the forehead. The younger boys and girls commenced with a single large piece of coal, fastened in a similar manner."*

At the time of the passage of Lord Ashley's act, in 1842, there were no less than two thousand four hundred females employed in the coal pits of Scotland.

XXXII. EAST-LOTHIAN COAL-FIELD.

We follow the arrangement of the author of an article in the "Glasgow Practical Mechanic."

The upper coal series in this group comprise six coal seams, which have a total thickness of more than twenty-six feet, within a section of 750½ feet of strata. These are "the upper beds or group."

Below these six coal seams, are nineteen other workable beds of coal. The details of each show great fluctuation in the thickness at different working points within the basin. The minimum is thirty feet, and the maximum aggregate thickness is ninety-nine feet. The practical mean is probably upwards of sixty feet.

We are indebted to the labours of Mr. Milne for a more particular account of this coal-field than had hitherto appeared. According to this authority, there are between fifty and sixty coal seams exceeding a foot in thickness, and not exceeding thirteen feet; averaging about three and a half feet in the East-Lothian coal-fields. The varieties of coal here mined are four or more; the most distinguishable being the splint, the cubical, the cherry, and the parrot coal. The analysis of these kinds we shall give in our general tables. One hundred and nine faults traverse this coal region, and are nearly vertical. The trap dykes present the usual phenomena "of the expulsion of much of its bituminous qualities *from the coal*; and of the sandstone, shale, and other strata being *hardened*," when in contact with these dykes.

If all the coal seams, whether workable or not, are taken into account, there would be a total thickness of coal amounting to one hundred and eighty-eight feet, which fact is corroborated by an estimate of Mr. Bald. It

* Dunn's History of the Coal Trade, p. 121.

is thought that all the coal seams which are more than two hundred fathoms below the surface, are entirely unattainable, and that those in the trough of the Esk basin are not less than from five hundred to eight hundred fathoms below the surface.

"The Brunstain, or upper series," extending over ten square miles, near Edinburgh, is calculated to contain 710,000,000 tons;—the attainable "lower coal seams," two groups, in an area reduced from one hundred to fifty square miles, 5,000,000,000 tons. The gross quantity attainable, therefore, is five thousand seven hundred and ten million, 5,710,000,000 tons. Supposing one half to be allowed for waste, and a fourth more for coal already worked out, there would be left 2250 million tons, an estimate, we think, too low.* If the annual home consumption in Great Britain be twenty millions, this quantity of coal would supply the whole nation for one hundred and twelve years; or, if the whole could be extracted, it would last more than two hundred and fifty years, previous to complete exhaustion. The following calculation appeared in the Scotsman paper of Jan. 9, 1828. "After making every allowance, taking the coal at sixty feet thick, and eighty square miles, the specific gravity 1.329, and 500,000 tons as the yearly consumption, it gives a duration of 7200 years, independent of any supplies om Fife, West-Lothian, &c."

There are about 400,000 tons of coal annually raised in the district, the greater part of which is consumed at Edinburgh and Leith.

The East-Lothian coal-field forms the boundary of the great coal-field of Scotland, on the east coast, and on the south side of the Forth. Its length is about twenty-five miles, its greatest breadth six, and it covers an area of eighty square miles. The strata in the north-west division of this coal-field dip to the south-east, at an angle of about forty-five degrees, and in some places are nearly perpendicular; but in the south-east division of the field, the beds are nearly horizontal. Hence, these divisions are locally called "the edge-coal seams," and "the flat seams."

XXXIII. KILMARNOCK COAL-FIELD.

At Cumnock and Kilmarnock, in Ayrshire, conchoidal glance coal, from this region about 150,000 tons, are annually exported.

At Craigman occurs anthracite, passing into Plumbago or Graphite. The Kilmarnoch district is famous for the production of "blind coal" or anthracite. Mr. Dunn, who established the Caprington colliery here, mentions that the first three seams are of the common bituminous coal. "The fourth is of excellent blind coal, spec. gravity 1.60; and immediately beneath this lies a whin sill, or basaltic formation, which is understood to have been the means of converting the coal into anthracite, from its formerly heated state. This opinion is corroborated by the fact, that in proportion as the whin lies more near or more distant from the bed of coal, it is more or less of this nature. In certain margins of this coal-field, where the coal and the whin become considerably apart, the coal becomes again ordinarily bituminous.†

Coal in Basalt, near Dabry in Ayrshire; occurs four feet thick: spec. grav. 1.317: contains 25.77 of earthy matter.‡

* Memoir on the Mid-Lothian and East-Lothian Coal-fields, by D. Milne, Esq., 1839;—also in the Transactions of the Royal Society of Edinburgh. See also Mining Review, p. 149.
† Dunn, p. 123.
‡ Thomson's Outlines of Mineralogy and Geology, 1836.

XXXIV. SOUTH-WEST, OR AYRSHIRE COAL REGION.

The most south-western portion of the Scotch Coal area in Ayrshire, including some detached patches, whose separate areas we shall not here attempt to define. Near Girvan, according to Dr. Millar, "there are two or three seams of coal equal to forty feet in thickness."*

At the Mansfield colliery two seams crop out measuring 21 feet: and at a short distance from it is a bed of coal, thirty feet thick, lying under 10 feet of peat-moss, from which it is separated by only six feet of clay.†

Within these limits is the *Dalmellinton Mineral Field.*—Some proprietors of the south-east district of Ayrshire, have recently [1846] explored a mineral field near to Dalmellinton, of which a flattering announcement has been made. The carboniferous strata extend for about seven miles on both sides of the river Doon, whose "banks and braes" are thus found to possess a new value, of which the poet never dreamed. The sections exhibit a depth and thickness of coal altogether unprecedented in this vicinity. The "black band" is found in seams of two and a half feet thick and about six miles in length.‡

XXXV. FIFESHIRE COAL-FIELD.

Dysart coal was among the first wrought in Scotland, operations having been begun upwards of 350 years ago. Upwards of 100,000 tons are dug here yearly.§ According to Mr. Williams, the Fife coal-field extends on the north side of the Forth, from Stirling to St. Andrews, a distance of 45 miles, and is, in some places, 10 miles broad. The strata are arranged in a trough-like concavity dipping to the centre. The richest part of this coal-field, is between Dysart and Alloa.‖ Here, at the depth of 270 feet, the main coal is 21 feet thick.

The coal-field of Balgregy, is remarkably rich in the excellent variety called Parrot coal, where the seam is six feet thick. It is used exclusively for gas-works. The seam inclines at an angle of 35 degrees, and is situated close to the basaltic formation, generally in connection with the common bituminous coal.¶

We have no particulars of the magnitude of the coal trade of the Forth, but that it was of some importance at an early period, we infer from the fact, that an act of Parliament in 1663, made the Culross chaldron the standard measure of the kingdom.

Mr. Horner, in a paper read before the Royal Society of Edinburgh, has described a large tooth of the sauroidal fish, the Megalichthys, found in a mass of Cannel coal in Fifeshire.

XXXVI. BRORA COAL-FIELD OF SUTHERLAND, OF THE OOLITE PERIOD, CORRESPONDING IN AGE WITH THE COAL-FIELD OF THE MOORLANDS OF YORKSHIRE.

We have been made acquainted with this coal-field, chiefly through the examinations of Mr. Murchison.**

* Dr. Millar.
† Dunn, p. 124.
‡ Inverness Courier.
§ McCulloch's Gazetteer.
‖ McCulloch's Statistics of the British Empire, Vol. I. p. 273.
¶ Dunn, History of the Coal Trade, 1844, p. 119.
** Trans. Geol. Society of London, Vol. II. New Series, p. 293, 1827.

The first pit in this coal-field, was opened in 1598, by Jane, Conntess of Sutherland.

From the sections published it appears that there are two seams, besides some thin beds not workable. The quality is bituminous; of a cubical fracture ; burning to a white ash, but subject to spontaneous combustion, unless excluded from the pyrites which abound in the shale.

From the main seam, three and a half feet thick, about seventy thousand tons of coal were obtained, at one pit, between 1814 and 1826.

The Brora coal pit, in operation when Mr. Murchison visited it, in 1826, was sunk to the depth of 230 feet. The roof of the coal bed consists of a compressed assemblage of leaves and stems of plants, passing into shaley coal. It is particularly characterized by a large species of equisetum, which also occurs abundantly in the Yorkshire oolite coal-field.* This plant is described by Mr. König, and is thought by that naturalist, as well as by Mr. Murchison, to have largely contributed towards the formation of the coal.

The coal itself, which varies from 3ft. 3in. to 3ft. 8in. thick, is a pure bituminous seam, subdivided in the middle by a thin layer of pyritiferous shale, which has, at times, occasioned the spontaneous combustion of the whole mass. But for the evidence of the fossil shells and plants which testify to the geological age of this formation, it might readily have been supposed that this coal seam belonged to the true coal era.

Two sections of the borings for coal at the Brora colliery are published. The first is 251 feet deep ; the other 338 feet.

Subsequently to the foregoing memoir, appeared a description of the coal-field of Sutherland, by J. MacCulloch, M. D.† The space which this deposit occupies is very inconsiderable. It extends for some [twenty] miles along the shore, but in no place does it exceed a mile [three miles, Murchison,] in breadth; and occasionally, it is not more than a few yards wide. The author considers that the real area of the Sutherland coal-field is underneath the sea, to the eastward, and that the part which is now open to investigation is the western edge or border. This coal-field rests upon granite, and the strata belonging to the coal formation are in immediate contact with the primitive rock, throughout the greater part of their extent. The coal itself may be traced within a few feet, or even inches, of the granite ; the intervening matter consisting of shale.

Three coal seams have been worked here. The first is impure and abandoned: the second is three feet thick; and the third is from three to four feet, and of better quality than the others. An engine pit has been sunk, forty-five feet below this level; passing through two other and thinner coal seams, and a bed of fine fire clay.

Mr. Murchison states that the Sutherland coal differs in no respect from that of the true coal series, when subject to chemical analysis, but it offers a mineralogical distinction upon being pulverized ; assuming, like all lignites, a red ferruginous tinge, instead of the black powder of the true coal. It may be considered one of the last links between brown coal and true coal ; approaching very nearly in character to jet.

The Richmond coal-field of Virginia, and the Burdwan coal of Hindostan, are supposed to approach the period of the formation of this Brora coal.

* Figured by Young and Bird, Geology of Yorkshire, Pl. III. fig. 4, 5, 6. Also in Vol. II. Trans. Geol. Society London, Pl. XXXII. by Mr. Murchison, under Mr. König's generic name of *Oncylogonatum*.

† Journal of Science and the Arts, 1830.

Isle of Mull.—The oolite limestone contains a lignite bed which has been partially worked for fuel, apparently corresponding in geological position with the coal of Sutherland, and of the Yorkshire Moorlands.*

Isle of Arran.—Its geology was described in 1828, by Messrs. Sedgewick and Murchison, from whom we learn that it contains seams of coal which have been worked. It is here seen passing from the bituminous state to that of anthracite.

The Hebrides, contain slight traces of coal seams.†

Isle of Canna.—Bituminous wood, in trap tuff.

Isle of Skye.—Pitch coal, of a velvet-black colour, having a regular, woody internal structure, and burning with a greenish flame, occurs in trap rocks here.

Orkney and Shetland Islands.—Peat is the ordinary fuel of these northern islands, and no coal exists. No trees can be made to grow, and hardly a shrub is to be met with; which is the more singular, as the trunks of large trees are not unfrequently found imbedded in the moss and sand, both in Orkney and Shetland.‡

Royalties or Rents.—In 1841, near Paisley, the galeage or royalty was, on riddled coal, 6*d.*=12 cents, per ton; slack or dross coal, 1½*d.*=3 cents, per ton. The cost of this coal to the producer was, including the royalty, 2*s.* 8*d.*=64 cents per ton. Unriddled coal, 4*d.* to 4½*d.*=8 to 9 cents per ton.

Leases of Coal Mines in Scotland.—On this head we have again recourse to the practical authority of Mr. Dunn. "The general custom of Scotland provides for yielding to the landlord a royalty, proportioned upon the net amount of sales at the colliery, in conjunction with a certain or sleeping rent, payable half-yearly. This royalty is sometimes so high as ⅕th of the amount of sales; but, generally speaking, it is ⅛th. Of late years, many collieries have been let at 1-12th and even 1-14th of the amount of sales.

The law of fixtures being somewhat different in Scotland to that of England, some important points have arisen of late years, touching buildings, the tubbings in pits, &c. Also, the responsibility of landlords, in case of damage being done to property, by the working away of coal wherein the landlord has concurred and received his rent. Such was the case at Bartinholme colliery, in Ayrshire; in which the Earl of Eglington was made joint defendant with his lessees; in consequence of the colliery being drowned by the breaking in of the river Garnock; even two years after all working had ceased, and the colliery abandoned."§

Compressed Peat.—Of so abundant a substance, employed in its natural state of turf, for fuel, by the poor population of a considerable part of this country, we possess few particulars. But the same material, submitted to the pressure of a machine brought to perfection under the direction of Lord W. d'Eresby, has lately acquired a value not heretofore assigned to it. By this process it is made up in the shape and size of soap bars; and so powerful is the compression employed, that the original peat is hardly to be recognized in the black and metallic looking mass, which the machine perfects. The properties of this new fuel are found to be highly advantageous in certain manufactures to which it has been applied; such as for jewellers and steel forgers; and its economy is evidenced in the reduced prices at

* Murchison. † Fossil fuel, p. 118.
‡ McCulloch's Statistics of the British Empire, Vol. I. p. 325. § Dunn, p. 126.

which cutlery wrought with it is offered for sale. Sheffield razors, bearing the mark of "peat compressed," have been on sale as low as 27*s*. per dozen.*

Considering the great extent of peat-mosses in Ireland and Scotland, particularly in the Highland districts; this process or conversion of the matter to a dense and portable mass, seems not only to open for those countries a profitable branch of industry, for which the field is nearly as inexhaustible as the material; but, in furnishing a substitute, in some cases, for coal, promises to enlarge the resources of fuel, and to allay any alarm at the prospect of a termination of the coal of Great Britain.

The limestone of Caithness used formerly to be burned into lime by the aid of peat as a fuel.

Peat.—In the *Outer Hebrides* there are no trees; and, except in a few places, none can be raised. As coal does not occur, there would therefore be a great want of fuel, but for the presence of turf, which is the common fuel in all the islands: but in some of these islands the inhabitants are compelled to import their peat from other places, there not being a sufficient supply for their wants, on the spot.

About two thirds of the Outer Hebrides have been supposed to consist of peat earth, resting mostly on granite or gneiss, the points of which frequently protrude through the moss.

Submarine Forests.—One of these occurs, several miles in extent, on the shores of the Frith of Tay; another in the Frith of Forth, at Largo Bay.

There is also one in the Bay of Skaill, on the west coast of the mainland of Orkney, lying under twelve or sixteen feet of alluvium. A submarine forest has been described on the coast of Tiree, one of the Hebrides; and similar appearances are observable on the shores of Coll.†

See much additional information respecting peat, under the heads of Ireland, Holland, Bohemia, France, and the United States.

Iron Manufacture in Scotland.

Year.	Furnaces.			Annual make of Pig Iron.	Average annual make per furnace.	Shipped to foreign parts.	Shipped coastwise.
	In blast.	Out of blast.	Total.				
				Tons.	Tons.	Tons.	Tons.
1796	17			18,640	1,096		
1806	18	9	27	20,240	1,120		
1823	22		22	24,500	1,113		
1825	17	8	25				
1828				36,500			
1830	27			37,500	1,388		
1835	29			75,000			
1839	50	12	62	208,000			
1840	61‡			239,500			
1841				250,000			
1842	62			238,550			
1844	69			310,000			
1845	87	21	108	400,000		54,617	
1846	97	33	130	543,400		119,100	257,851
1847				500,000			

* Extract from the Perth Courier, by the Mining Journal, Vol. X. p. 354.

† De la Beche—Geological Manual, p. 145.

‡ All with hot air, excepting one.

Dr. A. Watt communicated an article to the British Association in 1845, on the iron trade of Scotland. He remarked that on comparing Mr. Jessop's table of the quantity of iron produced by the blast furnaces in 1840, the increase was no less than 374 per cent. in 1845, with the prospect of a continued proportionate increase. One million tons of coal were consumed in the pig and malleable iron works of Lanarkshire, in 1845.

At the close of 1846, there were 100 furnaces in blast, making on an average 110 tons weekly each, equivalent to 572,000 tons, annually. There were also 33 furnaces out of blast.*

ISLE OF MAN.

Expectations have been formed of finding coal on this island, and researches have been lately made, it is said, with fair prospect of success, in the neighbourhood of Peel, from whence specimens have been obtained.

The recently published account of the geology of this island by the Rev. J. G. Cumming, does give much encouragement to this opinion of the existence of the coal measures here.

Peat.—Nearly one fourth of this island is covered by turf-bogs and drift. It is usually ten or twelve feet thick, and contains timber of very large dimensions.

Abundant evidence exists of a submerged forest along the coast.†

NORTH WALES.

XXXVII. ISLE OF ANGLESEA.

This island is traversed, from north to south, by a belt or zone of the coal formation, fifteen miles long, and from one to three miles wide; being about eighteen square miles,=11,520 acres.

XXXVIII. OUTLYING COAL AREAS.

There are three other insulated patches of coal measures, shown by Mr. Greenough's map, containing, probably, together, six or eight square miles.

* Mining Journal, Dec. 26, 1846.
† Cumming on the Geology of the Isle of Man, 1846.

XXXIX. FLINTSHIRE COAL-FIELD.

An area of not less than one hundred and five square miles,=67,200 acres, besides eighty square miles of grit and shale, extending from south to north about forty miles. The ascertained breadth varies from two to twelve miles. Towards the south the formation dips eastward, below the new red sandstone of Cheshire; while to the north-east it is lost beneath the broad estuary of the Dee. We conceive, however, that these coal measures may extend greatly beyond their present ascertained limits; or rather beyond those limits defined on the geological maps: and that they may even be prolonged northward so as to join the great Lancashire coal-field; the intervening portion being merely overlaid and concealed by the new red sandstone.

It is worth noting here, that in a manuscript geological map of this coal-field, by the celebrated father of English geology, William Smith, and kindly permitted by him to be copied by the writer of the present passage, more than thirty-five years ago, that great original observer had, in some degree, anticipated the foregoing remark. In fact, he has appropriated full half the area of the peninsula, between the Dee and the Mersey, to this coal-field; notwithstanding it is covered by the new red sandstone; while to the south, he has prolonged the coal area to a far greater extent than is shown upon the modern maps of the region. It was his opinion that the coal-measures, although concealed by the overlying sandstone, could always be reached beneath it, even as far, probably, as the Shropshire coal-fields; thus enlarging the mineral area of the field in question to an immense amount.

In some respects I may be allowed to express an agreement with these practical views of my distinguished master, as regards the defining the workable boundaries of coal-fields. It is no new remark that, in his geological maps, Mr. Smith assigned more extensive areas to certain detached English coal-fields than have been admitted in our modern maps.

In some cases, doubtless, this may be explained, on the ground of his not then possessing certain essential details, which are now known to all. Those who remember this remarkable observer, know that he had ever most at heart, as a strictly practical man in coal matters, *the ascertainment of the workable limits* of each coal-field, rather than the defining those mere surface areas to which recent geognostic refinements have narrowed them.

Perhaps some modification of this latter mode of representing, or rather, practically speaking, of misrepresenting important mineral areas, might be advantageously adopted, in geological maps. The suggestion is made under no fear of being misunderstood.

Where the area of a coal-field has been adjusted to its due limits, by developing the spaces occupied by interposing formations of an older date, such for instance, as penetrate so singularly within the great Scotch coal-field, an obvious practical service must result. On the other hand, where the minutia of unimportant overlying beds are displayed on the map of any mineral area, so as to contract it to a space irreconcilable with its actual productive limits, a great error may be committed, and the practical matters with which the mining proprietor or adventurer has to deal, are either obscured or misrepresented.

Thus, in the case of the South Staffordshire coal-field, it has been held on good authority, to occupy sixty square miles. By the sinking through some thin overspreading beds, that area is lately enlarged to ninety square miles;

thus approaching Mr. Smith's early estimate, of somewhat more than one hundred square miles.* In the Bristol coal-field, coal is worked over three times the area represented on the geological maps.

So also we shall probably find in the Flintshire coal-field, that instead of one hundred and twenty square miles, there will ultimately be two or three times that effective area of productive coal formation.

These views are in perfect accordance with those of Mr. Prestwich, in his memoir of the geology of Coalbrook Dale; who, in concluding, calls attention to the important inquiry, whether there may not be buried beneath the new red sandstone districts of England, other considerable coal-fields, which now are unknown, because they have not been subject to disturbing agents similar to those which exposed the Coalbrook Dale district.† Since writing the foregoing passages, we perceive by Mr. Dunn's recent work, that he also entertains opinions which harmonize with those we have expressed above.

Mr. Burr remarks, that the uncovered portion of this great coal-field is, however, so large and so productive, that a very long period may elapse, before it is worth while to make any extensive trials of the part presumed to lie buried beneath the more recent strata.‡

At the Mostyn colliery, five seams are worked, having an aggregate thickness of thirty-nine feet.§

The main coal, which lies towards the bottom of the series, is generally eight or nine, or more feet thick; and there are several other seams, varying from one or two to six feet in thickness. These principal seams are included in a perpendicular depth of fifty or sixty yards, measuring thirty-nine feet in thickness. When the rise coal was exhausted, a portion of the river Dee was enclosed by mounds or dykes, within which the present deep sinking descends to the Durbog seam, a depth of four hundred and fifty feet.

SOUTH WALES.

XL. SOUTH WALES COAL BASIN.

The computations of the superficial area of this magnificent coal-field have varied considerably; one making it eleven hundred, and another fourteen hundred square miles. The former is probably the correcter admeasurement, but perhaps still somewhat exaggerated. In the beautiful geological map of Mr. Greenough we have the means of ascertaining the productive area of this coal-field. If we exclude the lower unproductive sandstones

* The productive portion of the Bristol coal-field is on the last geological maps, similarly contracted by the surrounding new red sandstone, through which numberless pits are sunk, in the vicinity.

† Proceedings Geol. Society, Vol. II. p. p. 405.

‡ Mr. Burr in Mining Review, for June, 1837, p. 256.

§ Dunn, p. 137.

and millstone grit, the area of coal measures will not exceed 608,000 acres, or nine hundred and fifty square miles. This is one of the cases where the maps convey a greater appearance of coal surface than is strictly correct, owing to the expansion of the lower unproductive rocks that are usually associated with the coal. The reverse occurs in those areas to which we referred in a former page, where coal-fields are partially concealed by overlapping newer strata, through which, however, coal is often extensively worked.

In the present instance, as the South Wales basin is surrounded by the outcropping inferior formations, the unprofitable margin is but narrow.

In relation to the superficial area here, a local geologist not long since observed, that the true area of coal bearing strata is by no means easily defined, owing to various upthrows and downthrows, along the outer margin, detached areas, and concealed outliers, containing very valuable masses of coal, have been occasionally discovered, beyond the range previously assigned to the coal-field. As these areas lie the nearest to the shipping ports, their importance to the proprietors is great. That of Cwm Tillery, not long ago discovered between Newport and Pontypool, is a case in point; its existence having been wholly unsuspected.

We need scarcely mention the well known fact, that the South Wales coal-field is unequally divided between areas of anthracite and of bituminous or semi-bituminous coal; the latter being situated at the eastern, and the former at the western, division of the basin. The dividing line between these very different species of coal, is supposed to be the Neath Valley, where there is an immense and continuous transverse fault. Here the coal seams gradually pass from their anthracite condition and become slightly bituminous; increasing more and more so, as they extend eastward, until they become decidedly bituminous at Pontypool.

It has also been perfectly well ascertained, that all coal seams from the vale of Neath to Kidwelly, westward, are anthracite along their north crops; but the south crops of the same veins show them to be bituminous.* To these interesting facts may be added another; that in the bituminous part of the basin, the highest seams possess the greatest amount of volatile matter, as in the Kilmarnock coal-field in Scotland. So also in the anthracitic division of this basin; and a section has been published of a colliery in the vale of Neath, wherein a series of ten coal beds at the base of the section consists of pure anthracite, while much higher up in the same section, two seams exist which are perfectly bituminous or coking coals.†

Anthracite, as a domestic fuel, was held in small estimation, until, in the present day, the mode of using it has been learned in Wales; although very imperfectly as compared with the methods in general use in North America. The old impression invariably prevailed, as the present writer well remembers, thirty-eight years ago, only that anthracite was an inferior description of coal; applicable to very few useful purposes; to be resorted to as a kind of last resource; and attended with insurmountable difficulties in its employment. Mr. Bakewell, in 1813, in the first edition of his "Geology," remarked, "It is true that a considerable part of the coal in South Wales is of an inferior quality, and is not, at present, burned for domestic use; but, in proportion as coal becomes scarce, improved methods of burning it will assuredly be discovered, to prevent any sulphurous fumes from entering apartments, and also to economize the consumption of fuel in all our manu-

* Mining Journal, Vol. X. p. 310.

† W. Llewellyn in do., May 29, 1841.

facturing processes." The author of the "History of Fossil Fuel," quotes the same passage, without comment, probably being even then unaware of the improved process in the mode of burning of this so-called inferior coal; which is, nevertheless, the best for domestic uses that exists among the known mineral combustibles of the earth.

Passage from Bituminous Coal to Anthracite.—The coal basin of South Wales has had the advantage of an elaborate analytic investigation into the component qualities not only of every known seam within it, but of specimens of the same veins at numerous points along the course of their outcrops around the margin of the coal-field.

This herculean labour, so ably performed by Mr. Mushet,* exhibits scientific and practical skill of no common order. We trust that it will not be considered as an encroachment upon the privileges of the author, but rather as a tribute of our respect for his scientific attainments, that we have collected the results of those investigations in the tables of analysis, at the close of this work. Many other writers of experience and attainments, have, during the last twenty-five years, investigated extensively the geology of this important region; which is by far the largest anthracite coal basin in the world.

The gradual transition from the state of bituminous coal to that of anthracite, within the same coal-field, is not limited to that of South Wales. Mr. Murchison observed a remarkable parallel to this in the Donetz coal-field in Southern Russia; with only this difference, that the anthracite portion lies in the east division of the basin instead of in the west.† So also the little coal-field of Bourg-Lastic, department of Puy-de-Dôme, in France, contains one bed of pure anthracite, and another of fat bituminous coal, with long flame. A similar fact is observable in the basin of Saint Gervais, department of Hérault. We have noted the like occurrence in the southern anthracite coal-field of Pennsylvania.

Interior configuration of the Basin.—The investigations of late years have shown, that although, as regards the external structure of this magnificent coal-field, it possesses the basin form, yet that its interior exhibits marks of great disturbing forces, resulting in enormous dislocations, and subordinate curvatures. In a single case, there is a perpendicular displacement of more than six hundred feet. In another instance, near Newbridge, the strata are so upheaved as to form two basins within the principal area, or trough. These circumstances are decidedly favorable to the operations of the miner, in respect that they bring up within his reach the mineral beds, which, otherwise, would be too deep or too expensive to be worked to profit.

Geological Maps of the Basin.—There have been produced some well executed modern geological maps of the mineral region of South Wales. That of Mr. Greenough, although upon a limited scale, beautifully delineates the features of this area.

Mr. Logan exhibited to the British Association, in 1837, a detailed map of that part of the Welsh coal basin, which lies between the Vale of Neath and Kidwelly; prepared from the ordinance survey sheets. That of the ordinance survey is, of course, the most elaborate and highly finished.

Geological Models of the Welsh Coal-Field.—It forms an interesting subject for a model; the best and only true way of representing the geological character and external aspect of any country.

* Deceased in 1847, while these pages were undergoing revision.
† Proceedings Geol. Society of London, Vol. III. p. 722.

In 1830, Mr. R. C. Taylor presented to the Geological Society of London two models of about eleven square miles, forming a part of this mineral basin, in the vicinity of Pontypool. A short description of the same area, by this author, appeared in the Transactions of the London Geological Society, illustrated by a map.* For this, as the first work of the kind brought before them, the Society of Arts voted their gold Isis medal, in the same year.

Since then, geological modelling has been adopted by many who are engaged in practical operations and developments, and it is satisfactory to perceive that this method of illustration is at last beginning to be estimated as it deserves.

Mr. Sopwith has recently completed useful models, on a small scale, of some mining districts, particularly that of the Forest of Dean.

Mr. J. B. Denton communicated a paper to the Institution of Civil Engineers of London, "on the Construction of Model Maps."†

Mr. R. C. Taylor, exhibited to the Association of American Geologists and Naturalists, assembled in Philadelphia, in April, 1841, a geological model, on a large scale, of seven hundred and twenty square miles, or 460,800 acres, illustrative of a highly interesting portion of the coal region of Eastern Pennsylvania. This was the first geological model made in the United States.‡

Under the sanction of H. B. M. government and the direction of Sir H. T. De la Beche, the Museum of Economic Geology in London, is collecting a valuable series of geological models, of various mineral regions in the world.

Productive capacity.—Respecting the number of coal seams and the various speculations as to the amount of coal, we have many statements, beginning with Mr. Martin's. He enumerates twenty-two seams, amounting to ninety-five feet, of workable coal; besides several smaller beds, from six to eighteen inches, in thickness.§

At a later period, the Rev. W. D. Coneybeare, reported the workable coal at only sixty feet.‖ At the Cwm Afon Estate, near Port Talbot, towards the south side of the coal-field, seventy-two feet is stated to be the aggregate thickness, but whether it be all workable, does not appear. It comprises twenty-five seams, which vary from 1ft. 8in. to 6ft.¶

The whole series embrace about 1800 feet above the limestone, in thickness: but the upper coal seams do not occur in these localities, and are not included.

With respect to the quantity of coal within the basin, Mr. Bakewell's data would extend it to nearly a hundred thousand millions of tons, founded on Martin's estimate.** In contrast to this is the calculation of the Rev. W. D. Coneybeare, whose aggregate is short of twenty-three thousand millions of tons. The total thickness of workable coal admitted into this estimate, is sixty feet only; but excludes all coal that descends to a greater depth than two hundred fathoms; although some veins crop out at that elevation above the sea.

* Geol. Trans. 2nd series, Vol. III. Pl. XLII.

† May, 1842.—About 300 square miles of the middle coal-field, adjoining, have been roughly modelled, in 1843, by Mr. Gordon.

‡ Silliman's American Journal, Vol. XLI., 1842.—Also Trans. Association of American Geologists, 1843.

§ Philosophical Trans., 1806.

‖ Report of the House of Commons on the Coal Trade—1830.

¶ Miners' Company Prospectus, Map and Section—1841.

** Bakewell's Geology—First Edition 1813, Third Edition 1828—p. 181.

The writer of this article, in 1830, in a communication to the Geological Society, furnished an abstract of the workable seams of coal, iron ore, and fire clay, as proved by six sections at different iron-works, in the eastern part of the coal basin. This table exhibits the following results.*

Iron Works.	Coal. No. of Seams.	Coal. Aggregate of workable coal.	Iron Ore. Thickness.	Fire Clay. No. of beds.	Fire Clay. Aggregate thickness.	Thickness between the Bottom mine and the Black Pins Ore.
		Ft. In.	Ft. In.		Ft. In.	Yds. Ft. In.
Abersychan, - -	13	42 8	6 1½	10	47 3	119 0 2
Varteg, 1st Section,	14	43 9		7	45 6	119 1 5
Varteg, 2d Section,	23	46 5½	4 8½	13	42 7	120 2 6
Blaen Afon, - -	22	51 7			24 0	134 0 4
Coalbrook Vale,	17	38 8	7 4	5	13 0	127 2 6
Rumney, - -	26	55 1	60 small seams.	7	28 4	215 2 2

Mr. Llewellyn, a much more practical authority, contends against this estimate, as by far too limited. He considers that the deepest veins in that country will eventually be worked.†

We perceive that another writer in the Mining Journal estimates the total quantity in the basin at seventy-eight thousand millions of tons.‡ On Mr. Coneybeare's plan, if we calculate on the entire region as being workable, the result would be about sixty-two thousand millions. Another writer suggests that sixty-four thousand millions, on the common way of working, and deducting largely for waste and broken or defective ground, is an adequate amount.§

Mr. Logan's Section of the western part of the South Welsh Coal-Field.—Not having access to the published section by Mr. Logan, we shall quote the analysis of that elaborate production, as it appears in the annual address of the president of the Geological Society [Mr. Horner,] 26th February, 1846.

This vertical section "represents the beds as they are known to succeed each other, in descending order; the dimensions being the thickness of each bed at right angles to the plane of stratification. The coal measures rest upon carboniferous limestone, in an inclined and somewhat waved stratification; and although these measurements would vary in different places, from the swellings and thinnings-out which all strata exhibit, more or less, when traced to a distance, they are probably not far from the average amount over a large area.

1. From the top of the highest bed to the limestone base, the sum of the measurements amounts to nearly 7000 feet.

2. Reckoning only the greater divisions, when a difference of mineral character takes place, there are, besides the coal seams, 340 beds, from a few inches to 190 feet thick, without alteration of mineral composition; involving in the latter cases, long periods without any change in the nature of the detritus washed into the water where the deposition was going on.

3. These beds consist of sandstones, arenaceous and argilliferous slates, and clays, alternating without any apparent order of succession; sometimes one, sometimes another, lying upon the coal; and occasionally, but not frequently, the shale upon the coal is said to be carbonaceous.

* Trans. Geol. Society, Vol. III.—2nd Series—433.
† Mining Journal, May, 1841, Vol. XI. p. 173.
‡ Mining Journal, August, 1841—Feb. 1842. § Fossil Fuel, p. 152.

4. Interstratified with these beds are *eighty-four* seams of coal, from one inch to nine feet thick; the highest being covered by a series of beds of sandstone, &c., 200 feet thick; the lowest seam being separated from the carboniferous limestone by 1340 feet of similar sandstones and shales; making the coal-bearing strata, 5460 feet in thickness.

5. The seams of coal occur at very unequal distances; some are separated by a few inches only of shale or sandstone, others by as much as 360 feet.

6. There are twenty-three seams, occurring in succession, most of which are not distinguished by any term indicating quality; in two instances, one a three feet seam, they are said to be *bituminous*, and several seams are said to be *binding*, which means the same as *caking*; a quality which only richly-bituminous coals possess; the rest are merely called "coal." These twenty-three seams, with their interstratified sandstones and shales, occupy 1840 feet.

7. Then succeed thirteen seams, in a space of 1000 feet, and nine of these are described as "*not bituminous*."

8. The thirty-seventh seam, in descending order, is said to be *anthracitic*, and fourteen seams below it are so designated: then come four seams merely called "*coal*," and all very thin. Beneath the lowest of these, and separated by sixty feet of arenaceous shales and sandstones, comes a bed of coal, four feet six inches thick, called *anthracite*, with five feet of underclay; beneath this are seven seams called *anthracite*, and three more are intercalated, called *anthracitic*.

9. Between the 37th seam, called anthracitic, and the lowest of all, which is called anthracite, there are 22 seams intercalated, without having any distinctive term affixed to them, most of them very thin; but about midway, three occur near together, without intermediate sandstones and shales, but separated by clay containing stigmariæ.

10. The seams of coal, whether termed merely "coal," or bituminous, or anthracitic, or anthracite, have, with very few exceptions, underclays; and these, generally, but not uniformly, contain stigmariæ.

The two lowest beds of anthracite have underclays of five feet each; the third from the bottom has seven feet of underclay, each with stigmariæ. The underclay is of variable thickness; in no part more than fourteen feet, and except in a few instances, is always said to contain *stigmariæ ficoides*.

11. There appears to be no relation between the thickness of the underclay with stigmariæ, and that of the coal resting upon it. The thickest seam of coal, which is nine feet, rests on three feet of underclay, and there are instances of a seam of coal only an inch thick, with five feet of underclay stated to be *filled with stigmariæ*.

12. A bed of clay, eight feet thick, with stigmariæ, has no coal upon it, but a foot of carbonaceous shale; and above that forty feet of arenaceous shale; then four feet of clay with stigmariæ, covered by three inches of coal, and that overlaid by twenty-five feet of argillaceous shale and sandstone.

13. In no case is any difference stated in the mineral character of the sandstones or shales, either *over* or *under* the anthracite seams, or of any other coal seam."*

The author makes the observation, that throughout the whole 7,000 feet in the South Wales section, and throughout the 14,570 feet in Mr. Logan's Nova Scotia section, there appear to be no traces of any substance of a

* Quarterly Journal Geological Society of London, May 1st, 1846.

marine character; and, from any thing exhibited in the composition of the beds, all might have been deposited in fresh water.

In concluding this portion of his address, the writer calls the attention of geologists to some difficulties which the South Wales section offers to the commonly received and, he believes, well founded opinion, that anthracite is bituminous coal, the volatile parts of which have been driven off by heat, acting gradually from below; for we see that thin seams of common coal are interstratified with anthracitic seams and with anthracite. Neither do we find any signs of metamorphic action in the underclay in immediate contact with the coal, nor in the strata that lie between two seams of anthracite. "We must look to the chemist to explain all this, as well as for enlightenment on the formation of the different qualities of coal; but we must be contented to receive from him only indications and resemblances; for we must never forget, that in our experiments we can never have the volume of materials, the amount of pressure, and, above all, the duration of time with which nature has worked; and each of these, singly and combined, must have had important influence in modifying the results."

Anthracite Area.—The part occupied by anthracite extends from the Vale of Neath to Kidwelly, in Carmarthenshire; and after crossing beneath Camarthen bay, again appears in Pembrokeshire, and continues all across that country to St. Bride's bay.

From Neath Valley to Kidwelly the anthracite is confined to the north crops of certain known seams, (about twenty.) Their southern crops are semi-bituminous, but in Pembrokeshire the north and south crops are pure anthracite. In fact, it is now demonstrated beyond all cavil, both in Wales, in Pennsylvania, in Russia, in France, Scotland, and elsewhere, that anthracite or carbonaceous coal, and bituminous coal, more or less modified, may be, and are, in fact, in numberless instances, "part and parcel of the identical same seam of coal."*

We infer from the remarks of Mr. Llewellyn, an experienced operator in the South Wales coal-field, that he concurs in these views; and perhaps, from a local knowledge of some years duration in the same region, since the year 1810, as well as in Pennsylvania, we might be permitted to add our own limited testimony to the same facts. We agree, likewise, in the opinion, not alone advocated by Mr. Llewellyn, but by almost every geological writer of the present day, that the change from bituminous to non-bituminous, or anthracite, with its intermediate stages, beautifully exemplified in Pennsylvania, and in South Wales, has been effected by the influence of internal heat.

At an early period in geological investigation, it was taught by high authority, and advocated by pupils of the same school, that anthracite indicated *geological age* over bituminous coal, and that while the latter characterized the secondary formation, the former invariably marked the transition period. It is obvious how liable to error a geologist would be, in carrying such impressions into a new field of exploration. Thanks to the complete elucidation this subject has received, both in the new and the old world, there is no probability of any embarrassments of that kind occurring henceforward.†

Mr. Llewellyn is of opinion that "the *anthracitous principle* first developes itself in the lower strata. This is the case at Bute, Dowlais, Pen-y-daran, and Plymouth iron works; some of the upper seams, at those places,

* Mr. W. Long Wrey, in Mining Journal, Vol. X. September, 1840.

† M. Burat, however, still conceives that the anthracite of Pennsylvania belongs to an older system than the carboniferous period.

being entirely free from it, although the quantity of volatile matter progressively decreases in all the coals from Pontypool to Hirwain; beyond which place they become metamorphosed into anthracite. At Cyfarthfa, again, it is discernible in all the strata, but is much more strongly developed in the lower seams."* So also appears in the section of the coal measures at Blaengwrach, where the seams in the lower part of the section are of pure anthracite, but the two seams which crop out near the top of the hill are perfectly bituminous and coking coals.

There seems, however, to be some exception to the rule here laid down, or rather a slight modification of it, in the eastern part of the coal-field, which will be best seen in the table of analysis. For instance, at, and near, Abersychan; where the section of the whole series, in descending order, shows the following proportionate quantities of bituminous and volatile matter in the principal worked seams:

Highest, or	Mynyddyslwyn Veins,	28 to 36.90	per cent. volatile matter,	
	Cwm Tylery,	24.80	do.	From Mr. Mushet's tables of analysis.
	Red Vein,	25.50	do.	
	Big Vein,	25.70	do.	
	Rock Vein,	25.70	do.	
	Meadow Vein,	29.40	do.	
Lowest, or	Old Coal,	27.40	do.	

Thus we perceive that, although the highest seam is most charged with volatile matter, its amount does not greatly exceed that of the two lowest; that the one which contains the least bitumen is the highest but one in the group, and that the seams from thence acquire bitumen in the descending order.

Towards the western extension of this basin intrusive areas of trap or basalt occur; and, as might be expected, the anthracite there approaches nearer to a perfect carbon than at other parts of the district.

Coal Trade.—Independent of its home consumption, this immense mineral region has an increasing export trade—particularly to Ireland. There are many ports from whence coal is shipped—the principal ones being Newport, Cardiff, Neath, Swansea, Llanelly, and Kidwelly. From these points are chiefly exported the semi-bituminous varieties of coal now called steam-coal, of which similar kinds exist in Pennsylvania, and which recommend themselves by their favourable adaptation to a number of useful purposes in manufacturing and in domestic objects.

In 1830, the great bulk of the Newport coal then, and no doubt has done so ever since, supplied the whole southern part of Ireland, in every port; from Limerick on the west, to Wexford on the north, and some cargoes also went to Dublin. It also supplied the south-western coast of England, including the mines of Cornwall, from Bristol on the north, to Exeter on the south. It sent annually to Bridgewater, in Somersetshire, 90,000 tons. From this port of Newport, in 1829, there were exported 513,974 tons;—from Cardiff, 60,000 tons; Swansea, 114,000 tons, chiefly culm, small and stone-coal. Nearly all the coal sold from South Wales, eastward of the Steep Holms, goes from Newport; because the Monmouthshire Canal Company have a special exemption from the duty of four shillings per ton, on all coals going eastward of the Holms. The principal of these eastward ports are Bristol, Bridgewater, Chepstow, and places up the river Severn.

* Mining Journal, May 29th, 1841.

On the southern English coast, the supply of coal was in about the following proportions, in 1830, as appears from notes made on the spot at the time by the present writer:

To Plymouth,	Two-thirds Newport or South Wales coal, semi-bituminous. One-third Newcastle, highly bituminous.
Kingsbridge,	All Newport coal.
Exeter,	Two-thirds Newcastle coal. One-third Newport coal.

Eastward of the latter, the sale of Newport coal did not extend. On the north-west coast the shipments of Newport coals, nearly as far as Caernarvonshire, enter into competition with the Liverpool coals; because the vessels in the trade bring with them Liverpool store-goods.

The points thus named indicate, pretty nearly, the range or area of sale for the South Wales coals. The supply to the London market was almost too insignificant to be brought into the account.

At the ports west of the Holms, the coal shipped is not usually held in the same estimation, for domestic use, as the Newport coal. The small coal or culm of Swansea and Neath, is of the intermediate kind, between anthracite and bituminous; and comes from the southern beds in the basin. Besides 50,000 tons of this kind, we are informed that there were shipped 64,000 tons of anthracite culm, for the use of furnaces, of steam engines, for smelting, and for lime burning.

Since the date of the foregoing notes a considerable coal exportation has been taking place to Spain, France, Malta, Egypt, and ports of the Mediterranean; also to the East and West Indies, chiefly for steam purposes. At the present moment, this steam-coal has the highest reputation of any in the world.

Coal Trade Statistics: Exports to Foreign parts.

Table of the shipments of Welsh coal from four of the principal ports, to foreign parts.

Ports.	1844. Tons.	1845. Tons.
Newport,	148,888	149,890
Swansea,	40,299	43,139
Cardiff,	23,037	33,096
Llanelly,	20,154	11.452
	232,378	237,577

Coal sent down to Newport.—In 1837, 517,066 tons; in 1838, 518,916 tons; in 1840, 558,104 tons.

Amount of coal and iron sent down by the Monmouthshire canal to Newport, in the fifteen years prior to March, 1843, and the seventeen years prior to 1846.—Up to 1843, 7,677,815 tons of coal; 1,999,700 tons of iron. Up to 1846, 9,142,687 tons.

General shipment of coals and culm from South Wales.—Chiefly to the south-western part of England and to Ireland, besides a small proportion exported to foreign parts. Estimated quantity in 1828, 904,896 tons. In 1841, 1,700,000 tons.

Coal Statistics.—Production and shipments of the bituminous variety.

Amount of coal brought down to the ports of Newport and Cardiff, in the following years.

Newport.		Cardiff.	Newport.		Cardiff.
Years.	Tons.	Tons.	Years.	Tons.	Tons.
1803	34,000		1841	613,196	
1829	513,976		1842	611,504	325,825
1837	517,066	227,671	1844	648,561	416,138
1838	518,916	189,081	1845	677,614	521,388
1839	483,855			Estimated,	
1840	558,194	248,484	1847	871,000	

Amount of semi-bituminous coal brought down to the two ports of Newport and Cardiff, during the period of 17 years, from 1829 to 1845, inclusive.

	Tons.	
Newport,	9,142,687	Total, 13,089,276 tons to 1845, inclusive, and
Cardiff,	3,946,589	above 15½ millions of tons to 1847, inclusive.

The following estimate, with some modifications, shows the amount of the coals, which were mined and consumed in South Wales, or were exported from thence, in 1841.

			Tons.
Consumed in and about the iron works of all kinds, - -			1,500,000
" in the copper smelting at Swansea, - -			400,000
" " tin plate works, - - - - - -			150,000
Home consumption and domestic uses, factories, &c. -			1,050,000
Newport, - -	613,000	Exported or carried coastwise, -	1,700,000
Cardiff, - -	250,000		
Swansea and Neath,	500,000		
Llanelly and Loughor,	150,000		
Port Talbot, estimated,	187,000		
	1,700,000		4,800,000

Probably 2,700,000 tons in 1847, brought to the ports.
Probably 7,000,000 tons aggregate, in 1847.

South Wales Foreign Export Coal Trade, for the most part, of the bituminous quality and steam coals.

	To Foreign Parts.		Shipped to London.*			
	Years.	Tons.	Years.	Tons.	Years.	Tons.
	1833	24,981				
	1834	30,404	Av. 4 years. 1828 to 1831	31,700	1839	45,816
	1835	39,299			1840	60,069
	1836	46,135	Av. 4 years. 1831 to 1835	37,247	1842	74,982
	1837	76,518			1843	81,725
	1838	65,902	1834	33,200		
	1839	68,633	1835	38,567		
From four principal ports,†	1844	232,378	1836	35,237		
	1845	237,577	1837	35,018		

* Evidence on the London Port Bill, 1838. † Official returns in 1846.

Prices of Welsh Coals.—Anthracite, stone coal or non-bituminous coal, shipped at prices varying from 8*s*. to 10*s*. per ton, equal to $1.92 to $2.50, being all large coal.

The cargo or wholesale prices of anthracite have been gradually decreasing in the Thames, until lately, when it is quoted at nearly one-fourth higher than bituminous coal.

Years.	Price per ton. Sterl. *s.*	*d.*	U. States. dolls.	Years.	Price per ton. Sterl. *s.*	*d.*	U. States. dolls.
1838	27	0	= 6.53	1844	19	0	= 4.60
1839	26	9	= 6.47	1845	19	0	= 4.60
1840	26	0	= 6.29	1846	19	0	= 4.60
1841	20	6	= 4.96	1847	22	0	= 5.32
1842	20	0	= 4.84	1848	25	0	= 6.04
1843	19	6	= 4.72				

Culm, by which is meant in the trade, either all small coal or large and small intermixed as it was mined, of the anthracitous qualities, is shipped at 3*s*. to 6*s*. per ton, equal to 72 cents to $1.44 per ton, on board; but large quantities are shipped at from 4*s*. to 5*s*. equal to from 96 cents to $1.20 per ton.* Culm is quoted at 19*s*. in the London market, in 1846.

Steam Coal.—Intermediate, Semi-bituminous, and Free-burning Coals.—In 1842, Swansea obtained the privilege of shipping coal as ballast; which can be obtained at from 3*s*. 6*d*. to 5*s*. equal to from 84 to $1.20 per ton.

In the same year, common coal was usually shipped at Swansea for $1.32; and the best selected coal, for $2.16 per ton.

In 1838, the price of Swansea coal was 10*s*. equal to $2.42, and of Llangennech, 11*s*. equal to $2.66 per ton, on board: both being of the best steam quality, and more economical to the consumer than the Hartley coal of the north at 8*s*. 6*s*. equal to $2.06 per ton.† It has commonly commanded, in the London market, from $5 to $5.25 per ton; but the quantity is too small in requisition there, to induce much competition in price.

At Kidwelly, in 1844, the Gwendraeth coal was estimated to be put on board, including all charges, for 7*s*., or probably about $1.50 per ton. Sold in the Thames, in 1845, for 19*s*. 6*d*. equal to from $4.60 to $4.72.

SOUTH WALES AND MONMOUTHSHIRE.

Bituminous Coals.—They consist of various gradations, and are put on ship board for from 5*s*. to 8*s*. per ton, and the average may be taken at about 7*s*. equal to $1.68 per ton; but of course there are periodical fluctuations. Some kind or other of these varieties are exported to Ireland, and to Brest, and other ports of Southern France, Spain, Portugal, and the Mediterranean. To the Island of Cuba, also, a quantity of Welsh coal goes out, as back freights of the copper-laden ships, bound from thence to Swansea, &c.

The prices of Newport coals have not greatly varied, so long as the arrangements, as to price and supply, made from time to time, among the coal merchants, have been adhered to. In 1830, the established price to all places westward of the Holms, was 9*s*. 6*d*. equal to $2.30 per ton, and 6*d*. per ton gratuity to the captain. To all places eastward of the Holms, 9*s*. equal to $2.16 per ton. In 1841, the coal proprietors and shippers at Newport adopted regulations as to the quantity of coal to be brought down to the port; and to keep the price to "a liberal and remunerating sum," viz. to 9*s*. 6*d*. equal to $2.30 per ton, on board.

* Remonstrance to Sir Robert Peel, March, 1842, from the shippers and producers.
† Evidence on the Coal Trade Bill, 1838, p. 107.

The prices of these Welch coals on the quays in Cornwall was, on board:

	Years.	s. d.	Dolls.	
Merthyr coal,	1836	9 0	= 2.16	per ton.*
Newport and do.	1837	10 0	= 2.42	"
Newport and do.	1843	9 0	= 2.16	"

In 1843, the current price of Newport or Monmouthshire coal, delivered at ports in Cornwall, for the use of the mining establishments there, was 12s. equal to $2.90 per ton.

In 1838, Llangennech coal on board in Wales, 11s.=$2.66 per ton.
In 1846, Myrthyr coal in the Thames, - 25s.=$6.05 "
In 1848, Llangennech in the Thames, - 25s.=$6.05 "
The best Newcastle coals at the same time, ranging from 17s. to 19s. 6d. per ton.

Freight.—In 1830, the freight of coal from the Welsh ports to London, being a circuitous route from the Bristol channel, much longer than to a French port, used to be 14s. equal to $3.34 per ton; but it has been lower since that time. In 1838, the freight, both to the southern portion of Ireland, and to that of England, was 6s. equal to $1.45 per ton.

Coal Royalties, Galeage or Rent.—Our information on this head, as applied to present times, is but limited. We have known some collieries leased as high as 10d. equal to 20 cents per ton, for large coal, and 5d. or 10 cents for culm or mixed coal.

Some collieries above Newport were let, some years ago, at 8d. equal to 16 cents per ton, in 1830 to 1840.

In 1844, in the south-east part of the Welch coal basin, mines are on royalties, which vary from 4d. to 6d. equal to from 8 to 12 cents per ton. In fact, these appear to be the ordinary prices in the coal-field, at this time.

In the remonstrance of the Swansea coal shippers and merchants, to Sir Robert Peel, in March, 1842, when that minister contemplated imposing a duty of 4s. per ton, it was asserted that the proposed duty amounted to 800 per cent. on the usual royalty payable to landlords, for the best bituminous coal in the country; and above 1000 per cent. on the usual royalty for a large description of the non-bituminous coals.

Mineral Statistics of South Wales.—A late correspondent of the Mining Journal asserts as a fact, that three-fourths of the copper, four-fifths of the tin-plates, and one-third of the iron, consumed in the known world, are produced or prepared in the mineral basin of South Wales.

The copper works employ more than 4000, the tin plate works more than 5000, and the iron works, including colliers and miners, above 30,000 workmen; and, including their families, upwards of 150,000 inhabitants of South Wales live by means of these employments.

The weight and value of these Minerals, annually.

	Tons.	Value.
Iron, spelter, copper, and tin plates unmanufactured or raw materials, - -	729,325 =	£5,156,211
Increased value conferred on these materials through the manufacturing process,		£10,000,000
Coals exported from this region, -	1,500,000 =	725,000
Annually,‡	2,229,325 =	15,881,211=
In American currency to		$66,065,837

* Appendix, VIII. Report on the Coal Trade of the Port of London, 1838.
† See Royalties in Scotland, in Newcastle, in Germany, &c.
‡ Mining Journal, 14th Dec. 1844.

Fire-damp.—The accidents from explosions appear to be in great measure limited to the bituminous portion of the Welch basin. We have not made note of the number or frequency of the cases of fire-damp; but, as compared with the northern English coal-field, the instances are few and much less calamitous. The local newspapers and the Mining Journal have taken note of the greater part of these accidents. Among others, we observe, in August, 1840, the occurrence of three persons killed at Pentre colliery; seven burnt at Dowlais, and three at Plymouth. In August, 1845, twenty-nine miners killed in Duffryn colliery near Aberdare, out of 140 persons in the mine at the time.

Western extremity of the Coal Basin in Pembrokeshire, described by Mr. De la Beche in 1826. He states that stone-coal, culm, or anthracite is the only description of coal in this quarter. At Begelly collieries, three veins only are worked, containing eleven feet of coal.

This region is interrupted by areas of basalt, and the coal contains little or no volatile matter.

The Welch coal has acquired a high estimation in the market, for general use: but by the evidence before a parliamentary committee in 1838, the French do not so regard it. The Cardiff and Newport coals, being of the bituminous species, are not in such high repute, and do not answer so well for steam purposes as the Llangennech, the Swansea, and the Neath-abbey steam coals; the latter having more carbon and giving less smoke.

In their dealings in the coal trade, the French are very particular, and stipulate that all coal shall be screened in the port of delivery.

The Llangennech coal, in the London market, is generally quoted at about *5s.* per ton higher than the average of other coals.

Semi-bituminous Coals of the Welch Basin.—Steam coals or intermediate of the southern side of the basin.

Towards the close of 1840, an association was formed in London for the encouragement and protection of the Welch coal trade. They remark that "the durability of the ordinary bituminous coal, the very peculiar qualities of the anthracite or stone coal, and the great superiority of the intermediate or steam-packet coal of South Wales, are now so well ascertained, that it would appear as if nothing more were required to insure a preference at all the places of import which can be reached at a moderate rate of freight. It has only been, however, by very small degrees, by very great individual exertions, and by very considerable private loss, that the Welch coal has just begun to obtain a reputation in the port of London."*

The semi-bituminous coal of the south part of this basin, possesses many characters in common with certain coals in Pennsylvania; both of them being admirably adapted for steam engines; so much so as to have received the specific title of "*steam coal.*"†

The Craigola coal has been recommended for similar qualities; and the Llangennech has established for itself a higher reputation as a steam coal, and has been used on board steam ships in various parts of the world. In 1842, an Egyptian war corvette, belonging to Mohammet Ali, arrived from Egypt, at Port Talbot, in Glamorganshire, and was there loaded with the steam coal of that vicinity. In the same year the proprietors of the Risca colliery contracted with the Royal India Steam Navigation Company, to supply 72,000 tons of steam coals.

Analysis and Quality of the Welch Coal at different points and in different

* Mining Journal, Vol. X. p. 359, 1840; and Cambrian Newspaper.
† Monmouthshire Merlin, 1840.

beds.—The variations are as numerous as there are coal seams and square miles in the whole area. To particularize them, would be a herculean labour; yet that task, great as it appears, has been triumphantly accomplished by Mr. Mushet; to the results of whose labours we shall take the liberty of referring in detail, in another page.

Previously to this, we shall introduce a resumé of a series of interesting observations on the coals of this basin, by Mr. T. Forster.*

Table of Welch Coals.

Coal Seams in a line of Section from South to North.	Per 100 parts. Carbon.	Bitumen and volatile matter.	Ashes.	Description of earthy residuum left after combustion.
ANTHRACITE.				
Seam on Mynydd bach, Llaneidi,	89.85	8.65	1.50	Pale yellow ashes.
FREE-BURNING COAL.				
Clyn-wernon seam,	79.00	14.00	7.00	Heavy reddish ashes.
Pembrey seam,	82.00	14.50	3.50	White ashes.
BITUMINOUS COAL.				
Gelly Gile seam,	80.60	16.80	2.60	Red ashes.
Lwchor colliery, five feet coal,	78.50	19.00	2.50	
Globraise seam, Adair colliery,	72.20	27.50	2.30	Yellow ashes.
SEAMS IN DIFFERENT PARTS OF THE S. WALES COAL BASIN.				
Coxe's stone coal, Cwm. Tw. Anthracite,	91.50	7.50	1.00	do
"Pool coal," near Llanelly and Pembrey. Bituminous seam of Killymaen Ilwyd,	77.80	19.80	2.40	Reddish ashes.
Bushy seam, Llanelly. Semi-bituminous coal,	81.60	15.90	2.50	do
Great seam at Myrthyr. Semi-bituminous coal, of which the coke for the blast furnaces is made,	85.60	13.40	1.00	White ashes.

In further illustration of the various qualities of coal within the South Wales basin, we add a few other analyses.

		Carbon.	Vol. matter.	Ashes.	
Welch anthracite,	1st,	92.42	5.97	1.61	Analysis of Dr. Schafhaeutl.
	2d,	94.10	4.90	93	
Ynis-ced-win,		89.00	7.00	4.00	† Corresponding with M. Mushet's analysis.
Hirwain,		90.00	8.00	2.00	
Dawlais,		81.00	15.50	3.00	
Pontypool,		69.00	28.50	2.50	
Abersychan,		66.00	29.50	4.50	
Mynydd yslwyn,		68.50	27.00	4.50	

Steam coal.—We have alluded, as far as our space permits, to this valuable product of the South Wales mineral basin. The peculiar qualities of this fuel, and the experiments and results therefrom, have been made public in various ways. Among the latest of these may be mentioned the experiments

* Transactions of the Natural History Society of Northumberland, part 1.

† Mining Journal, Vol. XI. p. 118, 133, 149, 173; articles by Llewellyn, Brough, and others.

on Cameron's Coalbrook steam coal, detailed in the Mining Journal.* We cannot enter into these elaborate particulars, and our notice must be brief.

This coal is obtained within six miles of the port of Swansea, in which range a large amount of a similar species is known to prevail.

By experiments made at H. M. dockyard, Woolwich, with the steam coal and several other varieties, the results were the following.

Description of coal.	Weight of water evaporated by one pound of coal. lbs.	oz.
Merthyr, South Wales, bituminous coal,	8	0
Cameron's steam coal, S. W.,	9	$7\frac{3}{4}$
Llangennech steam coal, S. W.,	8	$14\frac{1}{8}$
Parson's Abbey, Craigola, S. W.,	8	$6\frac{3}{8}$
Hasting's Hartley Main, bituminous,	6	$14\frac{1}{8}$
Carr's West Hartley, do	7	5

The proportionate weights of the clinkers, the ashes, and the time in getting up the steam, were also taken into account. As relates to the economy in fuel, its first cost, the saving effected in stowage, and the absence of smoke in the steam coals, all these results, without reference to the interests of individuals or associations, form very important matters in the economy of steam navigation and manufactures.

Sulphur and Smoke, their absence, or inconsiderable amount, in the Welch Anthracite and Steam Coal.—It has been urged, by every one having any experience in anthracite, that one of its properties, by no means unimportant, is its non-liability to spontaneous combustion; which, it is well known, occasionally takes place with bituminous coals; whereby vessels have been lost at sea, and valuable property destroyed on land. A steamer belonging to the British government was destroyed in the Mediterranean a few years ago, from the spontaneous combustion of her stock of bituminous coal. By evidence before a parliamentary committee on the coal trade of London, in 1838, it was shown that the bituminous coals are liable to ignition in warehouses when they have been put in wet; and that they have ignited on board ships going to the East Indies.† Several instances of similar accidents have occurred in the United States. The absence of smoke, in war steamers using anthracite, is no small desideratum, to those who have witnessed the dense columns of black smoke, proceeding from steamers even at very great distances, at sea, employing smoke-producing coals.

So compact and dense a fuel also has great advantages in point of stowage space, over the ordinary weak bituminous coals. For long voyages, this concentration of power and economy of space, may easily be appreciated. It renders wholly unnecessary the adoption of patent contrivances for smoke prevention and consumption.

The value of the Welch steam or slightly bituminous coal is enhanced by this quality of burning almost wholly without smoke:—a property hitherto slightly appreciated, but which will, one day—and perhaps not far distant—be considered a prime requisite in fuel for steamers; or at least for those employed on naval service. By the ascent of the columns of smoke above the horizon, the motions of the steamers in Calais harbour are at all times observable at Ramsgate; from the first lighting the fires to the putting out to sea."‡

Steamers burning the fat bituminous coals can be "tracked" at sea, at

* March 14th, 1846. † Evidence, p. 121–2.

‡ Extract from the Sun paper, February, 1841. Also Mining Journal, same date.

least *seventy miles*, before their hulls become visible, by the dense columns of black smoke pouring out of their pipes or chimneys, and trailing along the horizon. It is a complete tell-tale of their whereabouts; which is not the case with those burning anthracite; as the latter kind sends forth no perceptible smoke.*

ANTHRACITE AND ITS USES.

Evaporative Power.—It will not be possible, in this work, to investigate the comparative merits of anthracite and bituminous coals, or of their intermediate varieties. There assuredly are highly appropriate and valuable properties in each. The experience of the last ten or twenty years, in the principal countries where they have been carefully experimented upon, and practically employed on the largest scale, has developed the relative advantages of each. More especially—both in Europe and in the United States—has it done "*justice to anthracite*," in pointing out the incalculable value of a species of fuel, previously rejected and despised, as amongst the most inferior and most impracticable of all the combustibles.

On this matter, the reader will find many instructive papers in Silliman's American Journal of Science—in the abundant correspondence scattered throughout the pages of the Mining Journal of London—in the Journal of the Franklin Institute of Philadelphia—and in other works appropriated to practical science on both sides the Atlantic: not forgetting the *Annales des Mines*, the "*Bulletin de la Société Geologique de France*," &c., the *Archiv für Mineralogie, Geognoise, Berghau, und Hüttonkunde, of Kanstea*, &c., the experiments of Dr. Fyfe, of Edinburgh, and some other authorities, occasionally quoted in this volume.

Dr. Fyfe's experiments show the evaporative power of pure anthracite over all other descriptions of fuel. The analyses of these combustibles were as follows:

	Fixed Carbon.	Vol. Mat.	Ashes.	Weight of water evaporated by one pound of coal.
Middling Welch Anthracite, mean of several kinds, *earthy and containing volatile matter*,	71.40	17.80	10.80	7.94lbs.
Common Scotch Bituminous, not caking, Middlerig, near Edinburgh,	50.50	42.00	7.50	5.88 "
Do. English caking coal,	67.00	31.00	2.00	7.84 "
Pure Welch Anthracite, according to the experiment of De Schafhaeutl,	92.42	5.97	1.61	10.56 "

Thus establishing the fact, that not only is the evaporative power in the ratio of the fixed carbon, but that there is a very remarkable approximation in the evaporative power to the proportion of this ingredient in each.†

Other experiments, by the same gentleman, show that the evaporative power of anthracite is 25.41 per cent. greater than the Craigola coal of Swansea; and 33 per cent. over that of the Scotch bituminous coals. Hence, he contends, as the practical evaporative power in fuel is according to the per centage of fixed carbon, it is important, for the use of steamers in

* New York Herald, October, 1841.

† Dr. Fyfe on the evaporative power of different kinds of coal. Edinburgh Philosophical Journal, April, 1841.

long voyages, to select that in which it is most concentrated; namely, the purest description of anthracite.

The results of another series of experiments on combustibles have been more recently made known. From these it appears as follows:

Number of lbs. of water to which 1 lb. of fuel will impart one degree of heat.

Wall's End, or Newcastle coal,	2,000 lbs.
Llangennech, South Wales, semi-bituminous,	9,000 "
Charcoal,	10,000 "
Anthracite,	12,000 "

From these, and from subsequent experiments by other parties, it appears that the Welsh anthracite exceeds the medium species called in Wales "steam coal," in evaporative power, more than twenty per cent.

Anthracite, and its application to Iron Making.—Respecting the adaptation of the Welsh and American anthracites for the manufacture of iron, there are many valuable communications in the Mining Journal of London, Vol. X. It has been treated on in various scientific works devoted to metallurgy and the useful arts. Among others, it has formed the subject of an elaborate treatise, published in Paris, by M. Michael Chevalier, in 1840. In America, a treatise on anthracite has been published, in Boston, by Mr. Johnson. The process of iron making with this description of fuel, has become common in Pennsylvania, and the difficulties, which for so many years seemed to be insurmountable, now appear to be entirely overcome. At the present day, the anthracite iron of South Wales enjoys a high reputation. We can adduce no better testimony than that of Mr. Mushet, in favour of cold-blast anthracite pig iron. After concluding a series of most elaborate experiments, he remarks, "it is hence abundantly evident that the pig iron now making, with cold-blast and anthracite, at the Ystalyfera ironworks, greatly exceeds in strength, in deflective powers, and capacity to resist impact, any iron at this time manufactured in the United Kingdom."

The anthracite district of South Wales is rapidly rising into importance in the production of iron. In 1847, there were no fewer than nine establishments, possessing thirty-two furnaces, in the Swansea valley. Ten years previously, there was only one, of three or four furnaces, in operation at Yniscedwyn. Twenty-three of these furnaces were in blast in September, 1847, making eleven hundred and fifty tons per week, or 59,800 tons per annum—a quantity by no means insignificant.*

Anthracite Exported from the District.—As to the trade in pure anthracite with London, or elsewhere, at present, so small a quantity of this description is needed for the market, that in 1842, out of 2,723,200 tons of coal imported into London, only 1283 tons were from Wales, in the shape of culm, or the small of Welsh anthracite.

Yet, if we mistake not greatly, the day will arrive when this great metropolis will seek from the mountains of Wales, her supplies of a mineral fuel far preferable to that which, from custom, she now considers so valuable; and which, from its imperfect combustion, among other causes, now darkens the air with smoke, and pervades a vast and densely inhabited area, with its sooty and noxious particles.

* London Mining Journal, September 4, 1847.

PREPARED FUEL.

Clay and Coal Dust, or Culm.—From remote times there has been in common use, in *Wales*, a compound consisting of refuse dust of coal, mixed with sea mud, ooze, or clay. This being made up into balls and dried, is, in that state, extensively employed for domestic purposes; not solely on account of the economy, but absolutely on account of the more intense heat they afford, when applied in that form, over pure coal itself. These balls, so cheap, and so readily made up, form a very important description of fuel; having the requisites of strength and durability of heat, at slight cost.

We remember observing them used in the large hotels of South Wales, for roasting and other cooking processes, in 1810, and subsequent years.*

In Ireland, there has been a corresponding practice, for time immemorial, by the country people, of artificially preparing a similar fuel to the compound used in Wales. Mr. Griffiths states that they use "pounded culm, with one-fourth part of clay, worked together like mortar, and then formed by the hand into balls of about three inches diameter."†

The *Chinese* have, for an unknown period, certainly for some centuries, been in the habit of employing precisely similar economical methods in the use of coal, or rather of that portion which we are accustomed to consider as waste and worthless. This they mix with certain earthy compounds, the details of which we give under the head "China."

At *Calcutta*, a similar process has been successfully adopted for preparing a fuel from the refuse coal dust. So also in Holland and the low countries.

Notwithstanding the extreme antiquity and publicity of the custom, among people of all times and all countries, there have not been wanting persons, both in England, in Continental Europe, and the United States, to assert the originality of their re-invention, and of the application of this well known combustible to its various and often proved uses. They have even proceeded, within the last few years, in all these countries, to take out patents for the same, as something new; and, consequently, as deserving of special protection in favour of the brilliant genius which led to the notable discovery. In fact, there are several existing patents in England alone, for similar compositions, made, with very trifling modifications, of the same simple materials.

In *France*, too, we observed notice of a (patent?) process, a few years ago, for putting into a useful form, the small slack of coal; of which enormous quantities are now wasted and lost or destroyed at the pit's mouth. This invention consisted of compressing the dust, slack, and fine fragments of coal, "into blocks, as solid as well formed coal." The mould invented by the ingenious Frenchman, will enable one workman to prepare 30,000 killogrammes, or thirty tons of this material, in one day.‡

In the *United States* of America, the same preparation of refuse anthracite was announced as a novelty, in 1838, at New York; and it was stated that the agents of the Great Western Steam Company had tested its value, by means of two hundred barrels of the compound on board the Liverpool steamer—one barrel of this fuel was asserted to be equal in intensity of heat and power of generating steam, to three barrels of coals!§

* We perceive a corresponding statement to our own in the Monthly Magazine, December, 1815.

† Griffith's Geology of the Leinster Coal District, 1814. Also, Dunn's History of the Coal Trade, 1844.

‡ Mining Review, November 9, 1839.

§ Pottsville Miners' Journal, December 8, 1838.

In *England*, as far back as 1630, a patent was obtained for "a new invention" for manufacturing *iron* and other metals, and burning bricks, lime, &c., with a fuel prepared from peat and turf, reduced to coke.

We have stated, elsewhere, that in *Flanders*, and in several parts of *Germany*, a fuel is artificially produced by coal dust, mixed with equal weight of clay. When dried, these masses burn, not only longer, but with a more intense heat, than does the coal alone.

This is precisely the principle on which the Welsh clay balls are prepared; and the Chinese bricks or moulds, are also formed of similar materials. So that not only is the custom in practice in remote parts of the world, but it has been in use for an extremely long period of time, in fact, beyond all record. That in those countries where fuel is scarce and very expensive, a resort to economical means of extending its use, by admixture with substances of themselves not combustible, is not remarkable. But when adopted almost at the pit's mouth, where coal is exceedingly cheap, and where the slack or fine coal costs no more than the clay or ooze with which it is compounded, and both are to be had for the trouble of fetching merely, we can understand that some practical advantage must be contemplated and experienced in the domestic employment of the artificial fuel, over the pure coal. We observed, long ago, [37 years,] in the principal hotels in Carmarthenshire, that the preference was invariably given, in the kitchens, for cooking, particularly for roasting, to the fuel made with the clay balls.

Dr. Buckland, in his "Bridgewater Treatise," speaking of the reckless waste of small coal in the mining districts, adverts to the almost incredible fact, that near Newcastle alone, more than a million of chaldrons of coal, per annum, being nearly one third part of the best coals, are destroyed by burning on the waste heaps, at the pits' mouths. As one remedy for this evil, and wanton destruction of so much excellent fuel, it has been suggested that the plan of mixing the fine coal with clay, and forming moulds, or balls, such as we have noticed in Wales, and are daily practised at Liege, Aix-la-Chapelle, and in the Chinese cities, should be more generally adopted. Thus, "at less than half the price of large coal, it will be seen, that these balls give out, in an open grate, an intense and long-continued, radiant heat, very superior to what new coals afford. If some speculative London brickmaker would import a cargo of the Newcastle small coals, make it up into balls, and then show, by experiment, that as much heat could be got from a ton of clay coal balls, as from a ton of large coal, and that they could be sold at less than half the cost, there can be little doubt that a demand would arise for a large portion of the Newcastle small coal, now so improvidently wasted."*

Precisely the same system is pursued in Flanders, and in several parts of Germany, particularly in the Duchies of Juliers and Bergens.

In an address to the Royal Polytechnic Society of Cornwall, Dr. Buckland adverted to the waste of fine coal, even at the places of consumption; and instanced the experiments on the rejected rubbish of coal at the dock yard at Woolwich.

They proved that an absolute increase of one third of power might be gained: that is, that every 200lbs. of small coal, prepared in the manner suggested, *would do the work of* 300*lbs. of the best Newcastle coal;* as tried more than twenty times on the steam engines at Woolwich, and attested by the government officers.

* Bridgewater Treatise.

This dust and rubbish, which, near Newcastle, is thrown away, or laid upon roads as gravel, or is burned to get rid of it, to the extent of more than 500,000 tons annually, if formed into a compost of river mud, quick-lime, and gas-tar, would adhere together, and form a breccia; and when made up into *brick-like pieces*, would be excellently adapted for stowage. Thus a vessel, with room for two weeks' store of Newcastle coal, might carry prepared fuel enough for three weeks. The attention of the British Association has been called to this subject.*

In 1838, another patent was obtained by Joyce and others, for the manufacture of artificial fuel, from coal dust, &c.

For additional notes on Prepared Fuel, see under the heads China, Holland, &c.

Another patent fuel, called *Wylam's*, was announced, March 2, 1844. This fuel is described as resembling a large brick, whose composition is as follows:

Peat and Coal Tar are boiled together, in about equal proportions, and the composition, when cold, is ground to powder. This powder is mixed with *coal dust*, heated to a temperature of 250 degrees; about ten per cent. of the same powder is mixed with the coal as a flux; and when the materials are intimately combined, the moulds are filled, and placed under hydraulic presses. A pressure of ten tons squeezes the mixture into the form of a brick, 13 inches ×6×4 inches, weighing 13lbs. each, the specific gravity of which is equal to that of coal.

This fuel is adapted to steam navigation. It is free from smell, and will sustain upwards of 500 degrees of heat without even softening. It burns freely; leaves but little ashes; has 25 per cent. more heating power than coal; occupies, weight for weight, a third less space than coal, and is impervious to wet.† In districts where peat is plentiful the proportions of coal and peat may be reversed. One of the objects proposed in the adoption of this artificial fuel, is the employment of large quantities of small coal, such as is accumulated around every colliery, and which otherwise would be entirely wasted and unprofitable.

This patent invention or composition, is due to M. Marchal, of Brussels. By the Mining Journal of May 31, 1845, we perceive that upwards of 600 tons of Wylam's patent fuel are manufactured weekly.

Dr. Mohun's Patent Fuel.—Again another artificial combustible, under the above title, was announced during the year 1844.

The merit of this fuel, is asserted to be in the compactness of form; it being less bulky for stowage, by fifty per cent., than bituminous coal or anthracite. The patentee announces a saving in cost of from forty to fifty per cent. at least. Its power of generating steam is less than one half the time now required by other combustibles in common use. No oxidation of the bars is produced, nor injury to the boilers; neither does any smoke or dust escape. We have not the details of the ingredients. Of course, as the statements regarding this and the foregoing, are mainly derived from the parties interested, we are unable to corroborate them; but we can perceive no improbability in either.‡

Another project was announced in May, 1845, and a company projected. The prospectus of this company furnishes some details respecting this com-

* Mining Review, 1839, p. 155. † Mining Journal, March 2, 1844.
‡ Mining Journal, March 9, 1844.

bustible substance. The invention is that of Mr. Warlich, who, "by the application of an unparalleled degree of heat in the manufacture, through the medium of retorts, renders it harder than any fuel ever before produced." It appears that this fuel is prepared from the small refuse coal, and screenings, of which such an enormous and daily accumulating quantity encumber the various collieries of Great Britain.

By order of the Admiralty, 150 tons of this fuel were taken out by the exploring vessels which proceeded towards the North Pole.

It is asserted to be from 20 to 25 per cent. more powerful than the coal from which it is made: and that, that which is made of Welsh steam coal is the most powerful fuel which has ever been produced. With respect to stowage, it occupies only from twenty-eight to thirty cubic feet per ton; whereas the general allowance for the stowage of coals, by government and shipowners, is from forty-three to forty-eight cubic feet per ton. 76 tons of this fuel, it is asserted, will go as far as 100 tons of the coal from which it is made. Consequently there is 24 per cent. of saving of expense, besides 33 per cent. saved in stowage.

To the foregoing list of artificial fuels we have to add yet another variety, announced under the name of "*Corke's Economic Firing.*" It is prepared from the small refuse coal, of which such immense quantities are accumulated around the English collieries, and is designed for burning in grates, and for other domestic purposes, being professedly considerably cheaper than coal.

There was also enrolled, in November, 1845, another description of Patent Fuel, called "*Ransomès,*" whereby blocks of this substance were formed of small coal, cemented by a siliceous admixture.

"*Stirling's Patent Fuel*" is of yet more recent date. By a pamphlet, published in 1846, we are apprised of the chemical analysis of this compound, by Professor Schafhaeutl. This manufacture renders valuable, as an article of commerce, all the small coal, which had, until lately, accumulated at the pit's mouth, and in many cases, had become an annoyance. The result of the analysis shows this artificial fuel to contain 86.21 per cent. of carbon, and 5.30 of hydrogen; which proportions insure a greater calorific power than that of the coal from which it is prepared. The proportionate weight and bulk occupied by a quantity sufficient for the voyage of a large Atlantic steamer are thus stated:

Coal for 20 days,	750	tons, occupying	33,750	cubic ft.
Artificial fuel, in bricks, for 20 days,	566	" "	18,395	"
Saving in weight,	184	" and space,	15,355*	"

Prepared coal dust in France.—The *Toulonnais* mentions certain experiments, of great interest, conducted in 1844, at the arsenal of Toulon, which are supposed to promise a large saving in the cost of fuel to the French government. M. Grandjeau de Fouchy, captain of a corvette, by a discovery of his own, has been transferring coal dust, of no use whatever, into blocks of coal. The ton of coal, prepared after his method, will only cost nine francs, whilst the English coal is selling at Toulon for twenty-two francs.†

* Mining Journal, March 28, 1844. † Ibid., Nov. 2, 1844.

Iron Manufacture in South Wales.

Years.	Furnaces. In blast.	Furnaces. Out of blast.	Furnaces. Total.	Annual production of Pig Iron in tons.	Average to each furnace annually.
					Tons.
1806	36	11	47	75,601	2,100
1823	72			182,325	2,532
1828	90			279,512	3,105
1830	113			277,643	2,457
1836				354,919	
1839	120			550,000	4,591
1841	162				

We have not the full returns for 1846, but the six principal ports exported 498,517.

In 1841 Sir John Guest stated the iron trade of his district [Glamorgan and Monmouth] employed at least 50,000 persons, and furnished subsistence to 100,000.

IRELAND.

Coal is ascertained to prevail in seventeen counties in Ireland.* Of the four principal coal districts, two of them are bituminous or blazing coal, and two contain carbonaceous or stone coal, the slaty glantz coal of Werner; anthracite, chiefly in the common form of culm.

The first bituminous coal district, that of *Connaught* is, just now, very imperfectly known; yet it will evidently have a very important bearing on the future interests of Ireland.

The second or *Ulster* coal district is smaller, but has been little investigated. Its coal is of the blazing or bituminous quality.

The *Antrim* coal-field is also bituminous, as are those of the counties of Cavan, Monaghan, northern and southern Tyrone, and Fermanagh. The coal district of the county Antrim was leased in 1840, by order of the court of chancery. It contains seams which are nine feet in thickness, extending over 7000 acres, and promises a complete supply to the cities of Dublin, Belfast, Londonderry, Dundalk, and the north-east and north-west portions of Ireland.

Anthracite occurs in prolonged basins in the counties of Cork, Clare and Tipperary. The *Leinster* anthracite occupies three districts, which are separated from each other by a limestone formation, in portions of Kilkenny, Queen's county, and Carlow. The *Munster* district is also anthracite.

* Griffiths.

Notwithstanding the great abundance of coal which Ireland possesses, and which is distributed throughout almost all parts of the island, yet her capital and principal cities and ports have hitherto depended upon Great Britain for their supplies of mineral fuel, both for domestic and for manufacturing purposes. To those who are unacquainted with the actual circumstances, it appears scarcely credible that this fine country has made so little use of the resources which have so bountifully been bestowed upon her. Among other causes, not political, which perpetuate this state of things, is the extraordinary facility and cheapness with which the ports of Ireland can be supplied from the principal western coal-fields of Great Britain. The cost of shipping these coals across the channel being so much less expensive than by inland modes of transportation, such as they were, has been heretofore prejudicial to the separate interests of Ireland, by preventing the employment of her population in that species of industry which has been so singularly profitable to Great Britain.* The consumers, in the ports and towns, have, however, no ground to complain; in as much as they in no other way, could procure their fuel at so cheap a rate. Yet we can scarcely coincide with the assertion of Mr. Wakefield, that "there is no vein of coal yet discovered in Ireland, which can come into general consumption."†

The projected railroads in Ireland will greatly facilitate the transportation and the supply of coals from the heretofore unworked beds in this country; of which beds, one alone, according to Dr. Warner, is capable of supplying the whole island.‡ In anticipation of this event, new coal mines have already been opened in the counties of Cork and Tipperary. We know also that, for several years past, there has been a great increase in the consumption of Irish coals in the city of Dublin.§

It is stated, by the Irish Railway Commissioners, that the bituminous coal mines of the northern districts are inferior, both in productiveness and in purity, to those of Great Britain; but that the anthracitous districts of the south are sufficiently extensive, and abounding in that description of coal, which, though less agreeable than the bituminous for domestic use, is most valuable in all cases where a strong and steady heat is required.

Royalties, Galeage, Rent or Landlord's Duty, formerly reached as high as one twelfth, and even one seventh; now it is seldom higher than one twentieth, and rarely exceeds a sixteenth, of the produce. The old system of extravagant rates of rent or royalty, was productive of prejudicial influence on the prosperity of the coal mines, and has been, of necessity, abandoned; as being too burdensome, and as giving too large a share to the landowner. The removal of these high charges has given a stimulus to mining, whether of coal or of the metallic ores, in Ireland, and has established rents on a more appropriate basis. It is to be hoped that sufficient encouragement will be afforded to the Irish population, to enable them to avail themselves of all the resources now lying dormant and unappropriated beneath their feet.

This is not the place to advert to the causes which, in that country, have paralyzed so long that spirit of enterprise which in Britain is so active. "A notion generally prevails in the latter country," observes Mr. McCulloch, "that the Irish poor are extremely ignorant. But this is by no means the

* The same condition of things and the same remarks apply to iron making.
† Wakefield's account of Ireland, Vol. I. p. 621.
‡ Dr. Warner's History of Ireland.
§ Dublin Mercantile Advertiser, Nov. 1845.

case. If elementary knowledge, or the being able to read, write, and perform ordinary arithmetical operations, be regarded as education, it is more generally diffused in Ireland than in England." "Where," asks Mr. Bicheno, "could the Ordinance surveyors find persons among the *lowest class*, to calculate the sides and areas of their triangles, at a half penny a triangle, as they do in Ireland, and abundance of them?"*

For further notes on the subject of rents or royalties, see under the respective heads of Wales, England, Continental Europe, and the United States.

Imports of coal into Ireland.—The principal foreign sources which have contributed mineral fuel to this country, are, from Scotland, through the Ayrshire ports; from England, chiefly from Whitehaven and Liverpool; from South Wales, by means of various ports along the Bristol Channel; while the coals of North Wales are forwarded chiefly from Chester. Dublin has heretofore derived her supply of the best bituminous coal mainly from Whitehaven and Liverpool. A small amount of stone coal or anthracite is also imported. The proportion and species of coal furnished to Dublin from the principal sources in 1828, are stated below. The first date is somewhat remote, but the return will serve for the purpose of illustration.

	Tons.		Tons in 1828.	Tons in 1835.	Tons in 1844.
From Whitehaven,	237,150	English Coals,	319,748	349,230	500,000
From Newcastle,	24,492				
From Lancashire,	58,106				
		Scotch "	135,064		
		N. & S. Wales,	163,738		
Imported into Dublin,			618,550		
The other Irish ports received in addition,			179,020		
Total in 1828,			797,570		

The original returns are made in chaldrons of 25½ cwt. each, which we have reduced to the common denomination of Tons.

The south coast of Ireland is mainly supplied with Welsh coal, shipped at Newport, except a little from Swansea and Cardiff, together with some anthracite or culm, for burning lime.

						s. d.	per ton.
Prices.—In 1841	Whitehaven bituminous coal,			at Belfast	12 0	=	$2.90
" In 1842	"	"	"	Dublin	13 0	=	$3.12
" In 1844	"	"	"	"	12 0	=	$2.90
" In 1845	"	"	"	"	19 3	=	$4.66

The advance in 1845, being full 50 per cent., was owing to the great demand for coal for making iron, and for locomotive power, in all directions.

Table of annual importations of Coal from Great Britain.†

Years.	Tons.	Years.	Tons.
1819	669,660	1826	779,584
1820	606,400	1828	797,570
1822	694,024	1829	840,246
1824	691,429	1835	1,001,378
1826	738,453		

* Mr. Bicheno's Report on Poor Laws, p. 41.

† Parlimentary returns of revenue, commerce, &c.

Import duty.—Until 1830, there was imposed a duty of 6*s.* a chaldron on sea-borne coals; also a coasting duty of 1*s.* 7½*d.* per ton. These are discontinued. There remained a quayage rate of 2*d.* per ton, and a toll of 4*d.* per ton, as a compensation to meters.

Exportation.—There is a small export of coal to foreign parts, of which the following is an abstract.

Years.	Tons.	Years.	Tons.
1833	3,946	1838	2,579
1834	4,078	1839	3,715
1835	2,695	1840	3,651
1836	3,944	1841	6,140
1837	3,410		

*Table of British Coals retained for Home Consumption in Ireland.— Triennial averages.**

	Years.	Tons.
Average of three years, ending	1790	338,934
" "	1800	362,499
" "	1810	491,374
" "	1820	675,910
" "	1826	711,876
" "	1830	796,773
Average of two years, ending	1832	851,424

XLI. ANTRIM, OR BALLYCASTLE COAL-FIELD.

This area, occupying the extreme north-east extremity of Ireland,—has been described by Mr. Bryce in the Trans. Geol. Society, vol. v., also by Mr. Griffiths, and since by other geologists. At that time the coal was not extensively worked, although it was formerly. This area is surrounded by trap rocks, which are newer than the chalk upon which they rest.

Some details of the coal-field were published in 1816, by Dr. Berger, and the Rev. W. Conybeare. They state the quality to be of the kind called slate coal. The vein then worked near Ballycastle was four and a half feet thick.† The coal measures underlie the columnar basalt at Fairhead, and the Gab colliery here is the most extensive and advantageous. Formerly the Ballycastle collieries used to send from ten to fifteen thousand tons yearly to market: in 1816, it was not more than two thousand tons. "Owing to prejudice, I believe, the country people prefer burning turf rather than coals, though ultimately more expensive."

Near Gab Cliff collieries, the coal is intersected, almost at right angles, by a trap dyke, the effect of which is to convert the bituminous coal at a considerable distance, on each side, to the condition of cinder, coke, or *anthracite.*

A newspaper paragraph, represents the bituminous coal of a large tract in this district, as being nine feet thick; an evident exaggeration.‡ Our opinion, we perceive, is fully confirmed by a correspondent of the Mining Journal, who has authority for stating that the coal seam is only three feet thick; very slaty, and principally used for burning lime; as, from the

* Parliamentary Returns.

† Dr. Berger—in 1816—with map, and numerous sections in Geol. Trans., Vol. III., old series.

‡ Dublin Mail, 1840.

abundance of *turf* in the neighbourhood no one thinks of using coal. The only other coal seam, near Ballycastle, is an eighteen inch one.*

The Antrim coal-field occupies the country on both sides of Fair Head. The collieries have been wrought at a very remote period, but no coal was raised at the time of the Railway Commissioners' Report, in 1838; owing partly to the difficulty of working to the dip of the old excavations, and partly from the want of a safe harbor for shipping.†

XLII. ULSTER, COUNTY OF TYRONE—DUNGANNON BITUMINOUS COAL BASIN.

Dr. Berger appears among the earliest geological writers on the north of Ireland. At that time, the limits of this coal-field were very imperfectly known, and the writer does not attempt to define them. Horses were the only power employed. The greatest depth of pits was seventy-five yards, and only thirteen tons of coal were raised in a day at the principal shaft. Several seams occur, the main one being six feet thick; but the coal does not cake, and the six feet vein alluded to, is denominated cannel coal.‡

Area about two hundred and fifty square miles. Although small, this district is much richer in valuable beds than any other in Ireland. In 1838, nine workable seams were known; varying from three to nine feet in thickness. At Coal Island, six beds have been discovered and worked, with various success, during the last century; but the stratification is so imperfect, and the consequent difficulty and expense of working the mines have been so great, that the adventurers have seldom obtained any considerable profit from them.§

It was announced, in 1846, that an exceedingly fine bed of bituminous coal was discovered near Tyrone, which bed was from twenty to thirty feet thick.

XLIII. TYRONE COUNTY.

A small area of coal lies to the west of this, in Ulster Province, supposed about fifteen square miles.

XLIV. ULSTER, MONAGHAN COUNTY.

An area of coal of about two hundred square miles. The coal-field of Carrickmacross rests upon a small tract of carboniferous limestone. The seams have not, heretofore, been considered thick enough to be worked to advantage.

XLV. CAVAN COUNTY.

A small patch of coal measures lies to the south of this, containing about fifteen square miles.

XLVI. LEITRIM COUNTY BITUMINOUS COAL DISTRICT, PROVINCE OF CONNAUGHT.

But little has been publicly made known of this region, and the area, therefore, must be only approximately estimated, as approaching to three hundred square miles.

* Mr. ——count, in Mining Journal, Vol. X. p. 61.

† Railway Report, 1838.

‡ From Geol. Soc. London, 1816, Vol. III.

§ Second Report of the Irish Railway Commissioners.

Mr. Griffith has given a sketch of this coal-field.

It is thought that after the Leinster and Munster districts, this is the most important in Ireland, and particularly with reference to the facilities it possesses for the manufacture of iron.

Seams of coal and ironstone occur in the north part of the county of Roscommon, to the west of Lough Allen. "These had been occasionally wrought to some extent, for a considerable period, but in general to the heavy loss of those by whom the works were carried on. It was, however, contended that this happened from the want of capital, or want of skill on the part of those employed, and the most exaggerated and delusive accounts were, at the same time, published of the value of the mines. At length, during the memorable year 1825, three companies were formed for working the coal and iron mines at Arigna and other places in this county. One of these companies after examining the ground, prudently declined proceeding any further. The energies of another were paralyzed by the fraud, jobbing, and mismanagement of some of its directors and agents; and the third, (the Irish Mining Company,) an enterprising and well-conducted association, ultimately abandoned the undertaking; their collieries having proved, if not absolutely worthless, not worth the cost of working them."* We believe that one of these abandoned undertakings has been lately resumed.

In a paper, addressed to the Geological Society, by Sir P. Egerton, in 1833, the author describes certain organic remains, obtained from the lower shale beds of the Connaught coal-field.

This coal district is situated on the eastern side of Lough Allen, near the sources of the river Shannon, and comprehends portions of the counties of Roscommon, Leitrim, and Sligo. According to the description of the Railway Commissioners, it consists of a group of hills of considerable elevation. The coal occurs in *detached basins*, near the summits of some of the hills. It has never been extensively wrought; and as there is only one workable bed known, varying in thickness from two to three feet, it is not probable that many large collieries will be established here. The Arigna iron works have been lately at work; and cast-iron of excellent quality is made there, at a moderate expense. The coal, though thin, is well adapted for the smelting of iron: the ironstone is peculiarly rich, and limestone is abundant in the neighbourhood.†

This iron work, although recently established, is, we believe, the first in which iron has been smelted by means of mineral coal in Ireland. The earliest iron mine put in work in that country, was in the year 1603. As the process of smelting was conducted by charcoal fuel alone, the supply was soon discovered to be inadequate. Accordingly, in the year 1700, there was an extinction of this manufacture in Ireland, for want of timber.‡

XLVII. THE LEINSTER OR KILKENNY COAL DISTRICT.

The principal anthracite or carbonaceous region. It is divided into three or four parts or basins, by intervening mountain limestone. They are situated principally in Kilkenny, Carlow, and Queen's counties; stretching into Tipperary in Munster.

Like the great coal-fields of England, these rest upon mountain limestone; but the coal is of an inferior quality to the English coals; or rather such

* Weld's Survey of Roscommon, p. 654.

† Second Report of Irish Railway Commissioners, 1838.

‡ Midland Mining Commission, First Report, 1843, p. 17.

was its original character, like that of South Wales, which time has shown to be of the very best description.

This district contains, according to the Railway Commissioners' Report, seven workable beds of coal, regularly stratified. The collieries have been worked for upwards of a century, and produced, in 1838, about 120,000 tons of coal and culm. The former is used for domestic purposes, and malting, the latter for burning lime. The upper beds, which are the purest, are now nearly exhausted; but three of the lower seams, which are very extensive, have never been worked.*

Mr. Griffith and Mr. Dunn agree in there being eight beds of coal here, between the surface and the mountain limestone. The latter is estimated at 500 fathoms in thickness, reposing upon granite. The eight coal beds make up an aggregate thickness of near 23 feet.

XLVIII. THE CARLOW OR CASTLE COMBER COAL-FIELD, IN QUEEN'S AND KILKENNY COUNTIES, LEINSTER.

Anthracite.—The coal mines of Castle Comber or Comer, are about sixty miles south-west of Dublin. The coal burns with extreme facility, and without producing smoke; but it is full of sulphur, and gives out a blue flame, with a very pungent odour, from the abundance of sulphurous acid.

Another mine is that of Ydof, province of Leinster, the first which was discovered in Ireland; the coal is so abundant as to supply all the neighbouring district. It is very heavy, burning in the manner of charcoal, but maintaining the fire much longer.†

The Castle Comer coal-field, in Kilkenny, has been described by Mr. Griffith, in 1814, and more recently [1844] by Mr. Dunn. The seams, which are known by the name "Kilkenny coal," are three and four feet thick, and consist of anthracite. Its specific gravity is from 1.500 to 1.600.

The annual raisings in the Leinster coal district were, according to Mr. Griffith,—

Of anthracite,	70,000 tons;	price at the pit's mouth,	20*s*. per ton=$4.84
Soft coal or culm,	100,000 tons;	" "	5*s*. per ton=$1.21

Castle Comer.—The best seams of Kilkenny coal occupy 5,000 acres of the *Castle Comer Estate*. It is sent to Londonderry, Cork, Waterford, Limerick, Dublin, &c., by various channels.‡ Mr. Dunn states that, notwithstanding the high price of this coal, the wants of the country always absorbed it. Whilst the Swansea coal cost 6*s*. [$1.44] and some other of the Welsh coal not above half that sum at the mines, the Castle Comer coal cost 18*s*. [$4.36] per ton at the pits, in 1844; at the same time its durability may be stated at half as strong again as that of Swansea. The smoke from this coal is highly sulphureous; and being heavier than common air, it is very offensive in houses if not carried properly away.

This anthracite was previously sold at the pits for 20*s*. [$4.84] per ton, and culm sold for 18*d*. per kish or barrel=4*s*. 6*d*. [$1.10] per ton; being greatly used by poor people in making up "clay balls."

In 1827, Mr. Dunn was deputed to examine the property, now greatly depreciated, and to ascertain how far it was capable of improvement. There were then about 60 pits working, which were seldom more than 100 yards from each other. "Some idea," adds Mr. Dunn, "may be formed of the

* Second Report of the Irish Railway Commissioners, 1838.
† Traite de l'eclairage au Gaz, par Pelouze pere, Paris, 1839.
‡ Mr. Griffith's Geology of the Leinster coal district, 1814.

manner in which the colliery had been worked, when I state that, from first to last, not less than 1200 shafts have been sunk upon the property."

At this time the best coal sold for 16*s*. 8*d*. and the culm at 3*s*. 4*d*. per ton, and in 1829, 13*s*. per ton, [$3.12] coal.

Produce of these Castle Comer mines:—In 1828, 48,004 tons coal and culm; in 1829, 38,204 tons do.; in 1830, 30,545 tons do.

In 1833, the coal proving deficient, both in quantity and quality, the arrangements were broken up, and the mine abandoned.

The Grand Canal Company's colliery at Donane, in Queen's county, is now working with greater success. The Rushe's colliery has been lately founded by an English company.

Prices in 1843.—Coal, 12*s*. [$2.90]—Culm, 3*s*. 4*d*. [$0.80.] At Donane and Castle Comer, 15*s*. [$3.63]—Culm, 5*s*. [$1.20.] Collier's wages, 2*s*.=$0.48 per day—Banksmen's wages, 1*s*. 2*d*.=$0.28 per day. Engine men, 1*s*. 6*d*. to 1*s*. 9*d*.=$0.40 per day—at Rushe's Colliery, being higher wages at this place than at any of the neighbouring collieries.*

At the same time, 1843, coal miners' wages at Bilston, in the South Staffordshire coal-field, were 2*s*. 6*d*. to 3*s*.=$0.60 to $0.72 per day.†

In 1847, a good seam of coal, three feet two inches thick, was discovered on the lands of Blandsford, in Queen's county.

Coal or Anthracite in Basalt.—At Fairhead, county of Antrim.

XLIX. KILKENNY.

A small field or coal area, west of the last—not defined.

L. THE SLIEV-ARDAGH TIPPERARY, OR KILLENAULE ANTHRACITE COAL-FIELD, CHIEFLY IN MUNSTER.

This is an area extending over one hundred and forty square miles, or 89,600 acres. It is made up of a numerous series of coal basins; each from fifty to seventy yards deep, and from five hundred to seven hundred yards long. The coal of all this district, as well as of the Leinster coal tract, is wholly anthracite, *blind coal*, having a conchoidal fracture, a strong lustre, and thin stratified structure. The specific gravity of the Coalbrook coal is 1.610. Fire-damp is entirely unknown throughout this district.

Mr. Weaver has reported upon this coal-field, in the Trans. Geol. Society of London; but has scarcely furnished, in sufficient abundance, the details required for a satisfactory estimate of this region. This is accounted for by the small amount of works carried on, at the time, within these limits.

By what we can gather from a somewhat obscure description, the coal seams of Lismanrock average two feet thick; producing 2,352 tons of coal per acre, each. The price of coal at the pit's mouth, at the time of this communication, 1818, was 18*s*. per ton, and of culm, 6*s*. 8*d*. per ton.

The three last fields are generally comprised as "the Leinster coal district."‡

According to the railway report, in 1838, this coal-field produced annually, 55,000 tons of coal, and 53,350 tons of culm; total, 108,350.

The principal collieries are situated at Colebrook and at Coolquil, in the neighbourhood of Killenaule. The railway commissioners, in their second report, contemplated employing the anthracite of this region, for locomotive engines.

* Mr. Dunn's History of the Coal Trade, 1844, p. 145.
† Appendix to Midland Mining Commissioner's Report, 1843, p. 91.
‡ Mr. Griffith on the Leinster coal district. Also Dunn's Hist. of the coal trade, p. 140.

The Slievardagh collieries in Tipperary county are now worked with great success and flattering prospects. The coal is said to be of better quality than usually occurs in Ireland. A railroad is projected into this district, which will open a wide field for its mineral resources.*

LI. SOUTH MUNSTER ANTHRACTE COAL-FIELD, IN LIMERICK AND KERRY COUNTIES.

According to Mr. Weaver, it is about one thousand square miles, or 640,000 acres, in extent. Very little appears to be known of the number of veins of coal or culm it contains, or of their thickness, as there has not been much demand for it, or encouragement, consequently, to search for it Mr. Weaver thinks that the coal seams are comparatively few in number and importance. These beds lie in every variety of position, from horizontal to vertical.

In this region the anthracite is generally fragile, and hence is brought to the surface in the form of small coal, bearing the common name of culm.

The better portion of this district has beds of culm, extending from two or three feet, to ten, fifteen, and twenty feet; subject to frequent expansion and contraction between the walls, which sometimes approach very near together. In the other parts, the seams are commonly from eighteen inches to two feet thick, only; consequently, cannot be worked to much profit.

No excavations have hitherto [1835] been made to a greater depth than eighty yards from the surface. In so little estimation has this quality of coal been heretofore held, perhaps from not knowing how to burn it to advantage in culinary operations, that English and Welsh bituminous coals are consumed in preference, even on the borders and within the limits of this coal region. For burning lime, it is in limited request; and one colliery has supplied 25,000 tons annually, for that purpose.

One of Mr. Weaver's sections exhibits twenty-eight seams of different dimensions.†

Mr. Ainsworth has published an account of the cliffs and caves at Ballibunnian, on the coast of Kerry. Near Hunter's Path, he mentions seven beds of anthracite, occurring in what was then considered to be transition clay slate, but which is now known to be of no earlier date than the regular coal measures elsewhere.

Col. Sykes has described a part of the same coast of Kerry.‡

Mr. Dunn examined some of the anthracite or culm beds in the county of Limerick, and in the neighbourhood of the Shannon. At *Glenagower* he found the beds 12 inches thick. The price of this coal, which is chiefly used for burning lime, was, in 1843, 1*s.* 4*d.* per barrel, or 8*s.*=$1.92 per ton at the pit. At *Loughill*, the culm is seldom more than 14 inches thick. Here it is sold for 2*s.* 6*d.* per barrel, or 15*s.*=$3.63 per ton at the pit. Of course the quantity raised is inconsiderable; but we are told that the culm bed extends over a great neighbourhood, and has been very little explored. The price it commands shows the value attached to it.§ This district is capable of supplying the country, for centuries to come, with abundance of culm.‖

* Mining Journal, November, 1845.
† Geology of the eastern part of Ireland. Also Geol. Trans. Vol. V. first series.
‡ Proceedings of Geological Society, Vol. II. p. 394.
§ Dunn's History of the coal trade, 1844, p. 166.
‖ Railway Commissioners' Report, 1838.

LII. NORTH MUNSTER ANTHRACITE COAL-FIELD, IN CLARE COUNTY,

Is about five hundred square miles, or 320,000 acres, in area. The veins or seams of coals are not uniformly co-extensive with the coal-measures; at least they have not been noticed. Like the southern coal-field, these seams are, for the most part, thin. They lie, in general, flat or horizontal.* Mr. Weaver appears to entertain no very favorable prospect of the productive power of this coal district, and thinks that much remains to be done "in exploration of this hitherto untrodden region." That period may yet be far distant, if we look merely to a supply of fuel for local consumption; since the vast tract of peat-bog, covering the greater part of the coal-field, and extending from Mount Callan to Loup Head, is provided with an almost inexhaustible store of that useful combustible.

Several coal beds occur upon Mount Callan; others are exhibited along the shores of Mall bay, and in many places in the interior.†

All the coal of the province of Munster, except that of the county of Clare, was once denominated "transition coal," by Mr. Weaver, who considered that the true coal which overlaid the mountain limestone, was found in the latter county alone.‡ This is adverted to in his anniversary address to the Geological Society of London, by Professor Sedgewick, who notes, as the distinguishing characteristic of the Greywache or transition series of Ireland, that it contains beds of coal or anthracite.§

February 4th, 1835, Mr. Weaver communicated to the Geological Society that he retracted the statement previously made, and that he was now satisfied that the region contained the regular succession of old red sandstone, carboniferous limestone, and the coal measures. "I am now, therefore," he adds, "convinced that both the North and the South Munster coal tracts are referable to the great carboniferous order."‖

Antrim.—Brown coal, Wood coal, Bovey coal, Fossil wood, or Lignite.—Accumulations of some or all of these substances occur in various parts of Ireland, and are valuable substitutes for stone-coal and peat as fuel. Great quantities are found in the county of Antrim. Two beds of twenty-five feet, one of nine feet, and another of eighteen inches, have been known and worked for a great many years, at Portmore and other places on the east side of Lough Neagh. Another bed of thirty inches has long been worked at Ballinderry, consisting of bituminous wood, or wood coal. This much resembles the Surturbrand of Iceland. Of the same description are several veins of four or five feet thick, near Ballintoy, alternating with trap rocks. Although it does not burn well, it is an important substitute for peat. Also at Killymorris, near the centre of the basaltic area.

A remarkable circumstance, in connection with this species of lignite, has long been noticed at Bengore Head; where a considerable stratum of fossil wood is found between the rows of basaltic pillars. It underlies the upper columnar trap in the cliffs of Portnoffer, on the east side of the Giant's Causeway. At this place the wood coal has the exterior surface of some of its fragments penetrated by small nests of augite, imperfectly crystallized.

Mr. Griffith states that the tertiary lignites of the basaltic region in the North of Ireland, exhibit a variation, in thickness, of from three feet to thirty feet in the space of 100 yards. At Lough Neagh, these tertiary formations

* Jameson's Edinburgh Journal, October, 1830.
† Penny Cyclopædia.
‡ Proceedings of the Geol. Soc. London, Vol. I. p. 231.
§ Address, 18th Feb. 1831.
‖ Geol. Proceedings, Vol. II. p. 119.

attain a thickness of 294 feet; composed of alternations of wood coal, clay and sand.*

Turf, (English;) *Peat*, (Scotch;) *Torf*, (German;) *Tourbe*, (French;) *Turbary*, (a peat bog,) from the Latin.

So excellent, plentiful and cheap is this description of fuel in Ireland, that our sketch would indeed be incomplete did we omit to mention it. Its abundance and accessibility to the vast mass of the poorer classes, renders it of no small importance among the natural resources of the island. Not only is it the common fuel of the poor in the interior, and indeed of all classes in some districts, but it is also brought in barges by the grand canal, and consumed to a great amount along with, or instead of coal, in the capital itself.†

So extensive is the supply of peat in Ireland, that it has been estimated to occupy one-seventh of its entire surface. One of the mosses of the Shannon is described by Dr. Boase to contain one hundred and fifty square miles.

The supposed deficiency of good coal in Ireland is less felt as regards domestic than manufacturing purposes. Mr. John Classon, 1845, has stated that Ireland has two canals, running from Dublin, through 2,000,000 acres of turf bog. He mentions, among other instances of the value of this combustible, that a distillery company, by the judicious management of a bog, had their steam power for half the cost it would have been for coals; and were, at the same time, making an estate of reclaimed land for themselves.‡

The red peat bogs, which form so remarkable a feature of this country, are chiefly comprised in the great central plain of Ireland. Unlike the English mosses, they are rarely level, but undulating; and in Donegal, there is a bog which is completely diversified with hill and dale.

These bogs consist of moist vegetable matter, containing a great deal of stagnant water; and, after heavy rains, fogs, &c., sometimes burst, and inundate or overwhelm the adjoining country.§

At the meeting of the British Association in 1842, Mr. Griffith illustrated the mode in which he considered the coal measures had been formed, by describing the general condition of the peat bogs of Ireland. They appeared to occupy basins which had originally been lakes, but the peat moss had grown up to the level of the water, and afterwards, by capillarity, rose twenty or thirty feet higher. The bases of these bogs consisted of clay, covered by a layer of peat, which is composed of rushes and flags. Above this is another bed of peat, closely resembling cannel coal, possessing a *conchoidal fracture, and hard enough to be worked into snuff boxes.* It yielded twenty-five per cent. of ashes, and contained a large proportion of oxide of iron.

This bed was covered with black peat, containing branches and twigs of fir or pine, oak, yew, and hazel—only the bark being left; and where whole trees occurred, the roots were entirely gone. The surface was formed of ordinary bog moss, (*sphagnum*,) nearly white. The whole amount of peat in the bog to which Mr. Griffith referred would, he thought, form a coal seam at least three or four feet thick.||

We have seen a recent statement to the effect that the area of peat land in Ireland is now partially diminished; some of the bogs being reclaimed and converted into arable land, and others are exhausted, drained, or dug out.¶

* Proceedings of the British Association in 1842.
† History of Fossil fuel. ‡ Ibid., January 3d, 1846.
§ McCulloch's Geographical Gazetteer. Also his Statistics of the British Empire, Vol. I. p. 357.
|| Meeting of the British Association in 1842.
¶ Mining Journal, October, 1845.

County Clare.—The bog of Douragh, eastward from the Fergus, affords the principal supply of turbary to Ennis and Clare. The bogs in this district abound in timber. A fir tree, measuring thirty-one to thirty-eight inches in diameter, by sixty-eight feet in length, was some time since raised from a bog near Kilrush. The mode of finding bog-timber is rather remarkable. It is ascertained that the dew does not lie on the part of the bog immediately above a tree, as it does elsewhere. Its position can thus be easily ascertained before the dews rise in the morning, when the finder, after probing with a bog-auger, to ascertain whether the wood be sound, marks the spot with a spade, and proceeds to raise the timber at his leisure.*

The series of extensive bogs in the central part of the island, though separated from each other, have received the common name of "the Bog of Allen."

They vary infinitely in wetness, also in depth, composition, &c. They rest, in general, upon a stratum of blue clay, based on limestone, and are invariably above the level of the sea. Their greatest elevation, however, does not exceed four hundred and eighty-eight feet; the mean elevation being two hundred and fifty feet.

The drainage and cultivation of these extensive portions of the surface of Ireland, have long been regarded as objects of great national importance, and frequent attempts have been made to show that they might be effected at no very great expense. But there are few examples in any part of the island, and those under very peculiar circumstances, of successful bog cultivation. The attempts hitherto made to drain the bogs in Ireland, have not been very advantageous; and even had they succeeded, it is doubtful whether the bogs would have produced any considerable return. It is, indeed, by no means clear, supposing them to be quite dried, that they would not, in most instances, be rendered still more worthless than they are at present.†

These bogs are, however, not without their value. They supply the inhabitants extensively with their fuel. In those parts, indeed, where bogs are scarce, they are the most valuable properties in the country. In not a few localities, they have been wholly cut out; and where this is the case, and other bogs are not easily accessible, the inhabitants have sustained great privations from the want of fuel.‡

		Acres.
Cultivated land in Ireland,		14,603,473
Unimproved mountains and bogs,		5,340,736
		19,944,209
Lakes,		455,399
Out of this aggregate, coal, more or less, is estimated to extend beneath,	coal,	1,881,600§

The parliamentary commission to inquire into the nature and extent of the several bogs in Ireland, and the practicability of draining and cultivating them, reported in 1814, that "the extent of peat soil in Ireland exceeds 2,831,000 English acres, of which at least there are of flat red bog,

* Penny Cyclopædia, art. Clare.
† Wakefield's Account of Ireland, p. 105.
‡ McCulloch, Gazetteer.
§ McCulloch's Statistics of the British Empire, Vol. I. p. 329.

	1,576,000	acres, the most valuable.*
Of mountain bogs, on the surface of the uplands,	1,255,000	do
Total,	2,831,000	do
Total area of Ireland,	20,399,608	do

Mr. Bicheno remarks, that "the rainy climate of Ireland, and the wet occupations of the people, with the nature of their food, make a fire more important to them than to most others; and, in fact, is frequently the substitute for clothing, bedding, and, in part, shelter. Had it not been for the bog, the measures taken in former times to extirpate the nation, might probably have succeeded: but the bog gave them a degree of comfort upon easy terms, and enabled them to live under severe privations of another kind."†

Mr. Griffith,‡ from his own observation during twenty years, states an example of peat bog having grown at the rate of two inches every year;—an instance, probably, of excessive growth, under peculiarly favourable circumstances, yet valuable in its direct testimony to the fact that bog, fitly circumstanced, still continues to grow with undiminished vigour.§

We have seen an estimate in circulation, by which it is shown how important to Ireland are her peat bogs, in furnishing a valuable fuel, independent of her deposits of anthracite and bituminous coal. According to this calculation, the space occupied by bog, in Ireland, is 2,830,000 acres.

If, however, the quantity capable of being made into turf be taken as low as 2,000,000 acres, and at the average depth of three yards, the mass of fuel which they contain, estimated at 550 pounds per cubic yard, when dry, amounts to the enormous sum of 6,338,666,666 tons.

Taking, therefore, the value of turf as compared with that of coal, namely, as 9 is to 54, the total amount of turf fuel in Ireland, is equivalent, in power, to above 470,000,000 tons of coal; which, at twelve shillings per ton, is worth about £280,000,000 sterling, or $1,335,000,000, U. S.

Species of Lignites found in the Irish Peat bogs.—With respect to the trees which are so frequently found in the Irish bogs, Mr. Aher remarks: "Such trees have generally six or seven feet of compact peat under their roots, which are found standing as they grew; evidently proving the formation of peat to have been previous to the growth of the trees."‖ In the bogs in the vicinity of Londonderry, according to the report of the Ordinance Survey, in 1837, the fact above stated may be verified in relation to *fir trees*, the lowest layer of which is underlaid by from three to five feet thick of turf. Not so, however, with *oaks*, as their stumps are commonly found resting on the gravel at the base or on the sides of the small hillocks of gravel and sand, which so often stud the surfaces of bogs, and have been aptly called "islands" by Mr. Aher, and "hummocks" by the Americans of the south. It is a remarkable fact, although very common, that successive layers of trees or stumps, in the erect position, and furnished with all their roots, are found at distinctly different levels, and at a small vertical distance from each other.¶

* Fourth Report, 28th April, 1814.
† Ireland and its Economy, p. 28.
‡ Mr. Griffith, in the "Bog Reports."
§ Ordinance Survey of the County of Londonderry, 1837, p. 7.
‖ Mr. Aher, in the "Bog Reports."
¶ Ordinance Survey and Report of the County of Londonderry.

We have seen that the bogs contain two important families of trees,—the resinous or coniferous trees, which grew in successive layers or tiers upon the ancient surfaces of peat; and the hard-wooded, non-resinous trees, which grew upon the gravel at the original base. Of the former, the prevailing tree was the common Scotch pine or fir, *pinus sylvestris*;—of the latter, the oak, *quercus robur*, prevailed.

We may be permitted to note here, that in a "Notice of a Submarine Forest in Cardigan bay, North Wales," the author remarks on the occurrence therein of the pinus sylvestris, although the Scotch fir is now excluded from the native Flora.*

MISCELLANEOUS NOTES ON PEAT FORMATIONS.

Mr. Jameson has a remark that we must not overlook; that peat is peculiar to cold or cool climates; and thus nature has provided the constant means of supplying, through this source, the necessities of the people who occupy those climates, and who continually require fuel.

In Scotland, it is observed that the peat at the bottom of a mountain is more decomposed than that which occurs at its top; and that the lignites found in turf bogs or mosses, are more sound upon the summit of a mountain than at its base. It is also observed that the peat of the south of England is more decomposed than that of the north of Scotland: and the peat of France has more of the coaly appearance than that of England.

As we advance towards the warmer climates, vegetable matter is more rapidly decomposed, until, at the tropical regions, the putrefaction of animal and vegetable matters is so rapid, that it prevents the formation of any body of the substance and structure of peat.†

Cupreous Peat and Lignites.—We add one curious fact in connection with peat. In 1812, there existed a bog on the east side of Glendore harbour, in Ireland, which was so much impregnated with *copper*, that forty or fifty tons of dried peat, when burned, yielded one ton of ashes, containing from ten to fifteen per cent. of copper.

A parallel case recently occurred in North Wales, where a solution of copper, which was let loose by accident upon an adjacent peat bog, affected and impregnated the vegetable fibre in preference to the accompanying soil. Mr. Murchison conceives, with regard to the dissemination of copper through the vegetable matter, or its arrangement around the thicker branches of the fossil plants in the thin coal beds of the Zechstein of Permin, Russia, that they attracted around them the cupriferous matter contained in the transporting currents.

Silicified or calydonized Peat, is noticed as occurring in Iceland, with hyalite or opalized mosses, by M. Eugené Robert.‡

Uses and adaptation of Peat to various economical purposes.

Charred, coked, or carbonized Peat.—This substance can be charred, and rendered fit to be used like charcoal, in cookery and other domestic purposes, in the same way as wood or coal is charred, and in much less time.

For ordinary purposes, it is charred by some families on the kitchen fire, thus:—take a dozen or fifteen peats, and put them upon the top of the kitchen fire, upon edge. They will soon draw up the coal fire, and become

* Rev. James Yates:—Proceedings Geol. Soc. London, Vol. I. p. 407.
† Jameson's Mineralogy of the Scottish Isles, p. 152.
‡ Bulletin de Societé Géologique de France, tome XI. p. 350.

red in a short time; after being turned about, once or twice, and they have ceased to smoke, they are sufficiently charred, and may be removed to the stoves. By following this plan you keep up the kitchen fire, and have, at the same time, with very little trouble, a supply of the best charred peat, perfectly free from smoke; and the vapour is by no means so noxious as charcoal made from wood. Peats, charred in this way may be used in a chafer, in any room, without danger arising from the vapour.*

See abstracts of numerous reports on this subject, in this work, under the heads, Bohemia, Bavaria, Wurtemberg, France, Scotland, &c. Also for steam purposes in Holland.

For the production of *gunpowder*, many varieties of peat are superior to the charcoal of dogwood and alder.

For *gas*, its properties have been severely tested in Dublin, Paris, and Plymouth: yielding about the same as the Newcastle coal, but its light is superior in brilliancy and power.

For *pavements*, when combined with an artificial asphaltum, composed of carbonate of lime and coal tar, it forms a solid and elastic road, superior in many respects to native asphaltum. The tendency of this artificial asphalte to crack and break, is counteracted by the strong fibre of the turf; which, if added to the chalk and tar, while warm, acts as a binder when the mass is cooled, and obviates its brittleness.†

Analysis of Irish peat, of an inferior quality, from the Bog of Allen; made with a view to ascertain its calorific power, by Mr. C. Cowper of London. The experiment was pursued by the litharge test, recommended by Berthier. This consists in mixing a given weight of the fuel with a sufficient quantity of litharge, and heating it in a crucible; the heating power is in proportion to the quantity of lead reduced.

By Mr. Cowper's experiments, the following comparative results were obtained, being averages of six or eight experiments each.

10 grs. of good Newcastle coal gave	284 grs.
10 grs. of oven coke, - -	302 grs.
10 grs. of common peat, - -	144 grs.
10 grs. of same, coked in a crucible,	259 grs.

"The foregoing analysis is founded upon a well known fact, that the quantity of heat, generated during the combustion of any fuel, is in exact relation to the quantity of oxygen consumed in the process. Hence, in order to ascertain the relative calorific power of different kinds of fuel, it is only necessary to ascertain the quantity of oxygen which each consumes in burning."‡

These experiments show that seven tons of peat coke are equal to six tons of good coal coke.

Professor Everitt's experiments, similarly conducted, show that

10 grs. of peat coke, picked surface, gave	277 grs.
10 grs. of peat coke, lower strata, gave	250 grs.
10 grs. of pressed peat, gave -	137 grs.

Application of Peat to Iron making.

It has been asked, can peat be advantageously used in the manufacture of iron? Generally speaking, the answer has been in the negative. Yet ex-

* Loudon's Encyclopedia of Agriculture, 1831, p. 747.
† Farmer's Magazine, Vol. XVII.
‡ Byrne on Compressed Peat, Boston, 1841, p. 11.

perience proves that in such a matter we ought not to pronounce an absolute opinion.

The history of the making of iron with bituminous coal or coke, is the most striking instance of this truth. The English forge-masters maintained, with all the energy of conviction, that pit-coal could never be used in the fabrication of iron; and they treated with ridicule all who made such attempts. We have witnessed the triumphal results, and its universal and successful application. So also with the employment of anthracite or stone coal in the process of iron making. It had baffled, for a long series of years, every attempt to employ it; and but a short time ago it was pronounced so surrounded with difficulty as to be impracticable. We now see that it is managed with equal or even more facility than with the bituminous coal.

We shall show, in the progress of these pages, that it is not only practicable to employ peat as the fuel in fabricating iron, but that, at the present moment, it is absolutely in full operation on an extensive scale; not only in high furnaces, but in puddling and refining: in cubilot and in reverberatory furnaces; in forges; in fact, in nearly all the processes of iron manufacture.

The countries where this combustible is so employed, on a large scale, are France, Bohemia, Bavaria, Westphalia, Wurtemberg, and in several adjacent provinces; thus settling this question in the only way it ought to be answered; practically and successfully.

Table of Analysis of Peat, both in the Raw and the Carbonized State.

By whom analysed.	Carbon, Per cent.	Vaporizable matter, Per cent.	Cinder, Per cent.	Locality and Description.
David Mushet, Esq.	25.20	72.60	2.20	Scotch peat, raw state.
Dr. Kane,	61.04	37.13	1.83	Bog of Allen, Ireland.
M. Marcher,	65.00	22.00	13.00	Carbonized peat.
	37.00	48.00	15.00	Raw state.
M. Debette,	67.00	30.00	3.00	Bohemia, carbonized.
M. Berthier,	38.00	28.00	17.40	carbonized ?
	24.40	70 60	5.00	Wurtemberg, raw state.
Dr. C. T. Jackson,	21.00	72.00	7.00	Maine, U. S., raw state.
M. Sawge,	22.00	69.70	8.30	Ardennes, France, raw.
M. Diday,	9.00	58.00	33.00	Basse-Alpes, France, raw.

In a pamphlet on this subject, republished by Mr. Alex. S. Byrne, he remarks that charcoal iron is the best known at present in the markets; and that such is its value and superiority, that large quantities are annually imported into England from India and China, and sold at the enormous price of £36 [$173] per ton. Mr. Byrne contends that *Peat Coke is of still greater value than the best charcoal,* and that in the manufacture of iron it stands unrivalled as a fuel.

When properly compressed, two tons of peat coke occupy no more space than one of charcoal: consequently, where intensity of heat is an object, a much higher temperature can be obtained from peat coke than from the hardest and closest charcoal.*

Professor Everitt's investigations of the common Lancashire peat show that in regard to comparative specific gravity—

Compressed peat possesses	1.160
Less pressed,	.910
Peat coke, hard pressed,	1.040
Less pressed,	.913
Charcoal from hard woods,	.400 to .625

* Observations on the uses and advantages of compressed Peat, by Alex. S. Byrne, 1841, abridged from the American Repertory.

Hence it appears that the coke prepared from compressed peat is nearly double the density of ordinary charcoal. In common practice it is estimated that 100 lbs. of charcoal occupy the same space as 200 lbs. of coke. Peat coke would occupy, weight for weight, the same space as common coke.

Professor Everitt adds, that " where bulk of stowage and high intensity of heat are important considerations, the peat coke is superior to wood charcoal." Moreover, the density of peat coke, by means of a stamper press and the use of heat, can be carried up to 1.359, which increases the comparison in its favor.

The admixture of peat, even in its natural state, with common coke, in smelting iron, materially improves its quality; in some instances changing the pig metal from the state of " white iron" to that of " gray iron," technically called "foundery."

Good peat is shown to be preferable to any other fuel, not only for the process just mentioned, but in welding, and for softening steel plates, &c.

For the finer iron works, turf and turf-charcoal are known to be better than wood charcoal. Dr. Kane shows that the precious Baltic iron, for which from £15 to £35 per ton is given, could be equalled by Irish iron, smelted by Irish turf, for £6 6*s*. per ton.*

From another source we learn that iron, manufactured with peat fuel, is more malleable than Swedish; and that tools made from it are of a superior quality. It has been doubted whether peat can be used in the puddling furnace, but with a diminished produce; yet the working of iron by this fuel is known to improve its quality, and the welds, especially, are superior to those made with coal.†

It has been proved that, after peat has been well carbonized, it may be employed in puddling and reverberatory furnaces, and forges. As to its use in blast furnaces, peat, which is the lightest of all coals, would consequently seem to be the least fitted for the reduction of ores.‡ But even this difficulty has, in great measure, been surmounted in the high furnaces of Germany.

M. V. Lamy has made a series of experiments to determine the quantity of heat given out by peat, in burning, compared with other combustibles: the results are as follows:

One kilogramme, or 2¼ lbs., of the varieties of fuel mentioned below, evolved of caloric the following parts:

Wood charcoal,	75 parts.	Bituminous coal,	60 parts.
Coal-coke,	66 "	Charred wood,	39 "
Charred peat,	63 "	Dry wood,	36 "
Raw peat,	25 to 30 "	Wood with ¼th moisture,	27 "

Thus, as regards charred peat, or turf charcoal, it appears preferable to coal in the manufacture of iron, and is almost equal to wood charcoal.

Compressed peat, dried in a furnace, could be used with decided advantage in a puddling furnace.§ In fact, it is already in extensive use, and the results have been very carefully investigated by men of science, as well as of profound practical attainments, more especially in the iron districts of the Austrian Empire.

* The Industrial Resources of Ireland, by Robert Kane, M. D., 1844.
† Mining Journal, Dec. 6th, 1845.
‡ On the applicability of peat to manufacturing iron—Mining Review, 1840, p. 46.
§ Mining Review, quoting l'Ancre, p. 53.

Prepared Turf or Peat for steam purposes, and in various processes of working iron and steel.—A patent has been obtained by Mr. Williams, managing director of the Dublin Steam Navigation Company, for a method of converting the lightest and purest beds of peat moss, or bog, into the four following products: each of which possesses very valuable properties.

1. A brown combustible,—solid—denser than oak.
2. A charcoal, twice as compact as that of hard wood.
3. A factitious coal.
4. A factitious coke.

Mr. D'Ernst, artificer of fire works to Vauxhall, has proved, by the severe test of colored fires, that the turf charcoal of Mr. Williams is twenty per cent. more combustible than that of oak. Mr. Oldham, engineer of the bank of England, has applied it in softening his steel plates and dies, with remarkable success.

But one of the most important results is, that with ten cwts. of the factitious coal, the same steam power is now obtained, in navigating the company's ships, as with seventeen and a half cwts. of pit coal, alone; thereby saving thirty per cent. in the stowage of fuel. What a prospect is thus opened of turning to admirable account, the now unprofitable bogs of Ireland; and of producing, from their inexhaustible and reproductive stores, a superior fuel, for every purpose of arts and engineering!*

From the experiments of Mr. Le Sage, charred ordinary turf seems to be capable of producing a far more intense heat than common charcoal. It has been found preferable to all other fuel for case-hardening iron; tempering steel; forging horse-shoes; and welding gun barrels.† Since turf is partially carbonized in its native state, when it is condensed by the hydraulic press, and fully charred, it must evidently afford a charcoal very superior in calorific power, to the porous substance generated from wood by fire.

It was announced, a few years ago, as an important fact, that the steamers, plying between Limerick, Clare, and Kilrush, in Ireland, were using peat for their fuel. The Garry-Owen, steamer, has made the passage between Kilrush and Limerick, fired with turf, [although in the midst of a coal region,] in three hours and twenty minutes. We have been recently told that the Shannon steamers mostly use it, and that it is growing into use in mills and factories.‡

Turf forms an important article of transportation, to Dublin, &c., on the Grand canal. In 1831, 48,000 tons were conveyed on this canal.

The city of Londonderry receives its supplies of turf from the county of Donegal.§

See further, various details as to the value and uses of peat, under the heads of Holland, England, Hanover, Denmark, Scotland, Prussia, Austria, Bohemia, France, Bavaria, Wirtemberg, and the United States.

We continue our notices, derived from various sources, of the importance of this heretofore neglected species of combustible.

The editor of the Mining Journal of London, in an able article, of Dec. 20th, 1845, warmly advocates this subject, with reference to Ireland. He remarks that among the numerous resources which nature has placed in such profusion throughout Ireland, there is, perhaps, none to such a prolific extent, or in comparison, so little valued or turned to the uses for which it is so eminently calculated, as peat or turf.

* Ure's Dictionary of Arts and Manufactures. † Repertory of Arts, Vol. V.
‡ The Industrial Resources of Ireland, by Robert Kane, M. D., 1844.
§ Ordinance Survey of Londonderry—p. 200, Vol. I.

From Dr. Kane we ascertain that the light turf, which is so much burned, weighs 500 lbs. per cubic yard; while the most dense varies from 900 to 1100 lbs., being about half the average weight of coal. Thus, furnaces, to burn a similar weight of coal and turf, would require double the volume of the latter.

We have alluded, in a previous page, to Mr. Williams' prepared turf. His method of preparing it, is as follows. When freshly cut, the fibre of the peat is broken up, and the mass is placed between cloths and pressed by a powerful hydraulic press; which condenses it to one third of its original volume, and to three fifths of its weight, through the loss of moisture.

This condensed peat, when carbonized, gives a fine coherent coke, containing little ashes, and amounts to thirty per cent. of the weight of the turf. Its density is greater than wood-charcoal, and it can be manufactured for 20*s*. per ton.

That this combustible can be successfully employed in iron works, in the puddling and second fusion, in the re-heating and rolling of the metal,—in-fact, in all the operations which are effected with coal in England, is practically demonstrated in the furnaces of Ransko, in Bohemia, and of Königsbrunn in Bavaria, the details of which appear in another part of this volume.

A work has been published, 1845–6, by Mr. Mallet, of Dublin, "on the artificial preparation of turf," showing the immense advantage to Ireland is, or rather might be, its peat-bogs. We have no room here for details of his experiments. He considers the best method of taking turf, instead of cutting it into sods, is, to work it up like mortar, and thus to break the fibre, and mould it into bricks; which are afterwards kiln-dried.

M. Goldenberg has reported on the successful employment of gas, obtained from peat, for the refining of iron and the puddling of steel, in various parts of Germany.

He considers that the successful result of this method will be of the greatest importance to the whole of northern Germany, where extensive beds of turf and lignite prevail.

In their solid state, these combustibles have, heretofore, been of little use in the manufacture of metal; but being reduced into gas, they become a great resource to those districts.

The same process would not be less beneficial to France, which possesses some very rich peat bogs, and scarcely turned to use.

It is also adopted in Sweden, where coal is scarce.

Iron manufactured through the agency of Peat.

Ireland has heretofore paid one million sterling annually to England for iron. It is now contemplated that she will not only keep at home this amount of capital, but will even receive a much larger sum from England for a description of iron which the latter cannot do without, and which, for want of peat or charcoal, she cannot manufacture.

It is expected that Ireland will henceforward have it in her power to supply this iron on better terms than it can be imported from the Baltic, and, consequently, that the large sums now paid for foreign iron, will be spent in the former country, to the great benefit of its population.*

We can find but little further space to cite with reference to the employment of the peat of Ireland the facts and opinions with which intelligent persons have recently furnished us. Among others is an able pamphlet by

* Editorial remarks, Mining Journal, July 11, 1846.

J. W. Rogers, pointing out a mode for the permanent employment of the overplus labouring population of that country. He suggests the employing them in preparing different kinds of fuel from the immense bog districts. The writer "has been in the habit of having peat charcoal prepared for smith's use, infinitely in preference to any coal," and states that "if within the reach of the manufactories of iron, at the price at which it can be produced, no other fuel would be used." We add the following extract from this work :—

"Charcoal of peat has been found, by analysis, to possess almost identical qualities with wood charcoal. Prepared, as it hitherto has been, however, it is more friable, and therefore more fitted for many purposes—such as the working of iron, manufacture of gunpowder, &c., &c., and also as a fertilizer—the great value of which is not known in this country; but peat charcoal is quite capable of being prepared so as to obtain a density, little if at all inferior to wood charcoal."

The calorific value of peat coke may be commercially averaged as equal to coal coke. The evaporative powers of the two are nearly equal; but peat coke has the advantage of freedom from sulphur. Its superiority is decided when used for the following purposes :—

For the working of malleable iron.

For melting unmalleable or cast-iron.

For all descriptions of brass and copper work; and

For the smelting and general manufacture of iron from the ore.*

Mr. Rogers has followed up this interesting subject by a pamphlet entitled, "Appeal for the Irish Peasantry," in relation to the employment of the Irish peat. He remarks that "when compressed coke is carbonized, it gives a fine coherent coke, which contains very little ash, and amounts to about thirty per cent. of its weight. The density of this coke is greater than that of charcoal—being found to range from 0.913 to 1.040." The objection, as regards ships of war in action, that the splintering is so great, that this material cannot be safely employed, is met by the assertion that the evil entirely arises from one cause—that of iron being now made solely by sulphureous fuel. Iron made with the peat charcoal will not splinter.

It is remarked in the Mining Journal that the smiths in the country surrounding Dartmoor travel twenty or thirty miles to get the peat for charring, and that horse-shoes made with it are known to produce almost double price.†

* Mining Journal, October 31st, 1846. † Ibid. January 30.

KINGDOM OF FRANCE.

GENERAL STATISTICS.

Area of France 202,125 square miles; or by the returns of 1846, 527,686 square kilometres = 203,686 square miles. By the returns of 1836, 127,045,650 English acres. By those of 1846, 130,359,000 English acres.

Population in 1831, 32,569,223 persons. In 1842, 34,194,875 persons In 1846, 35,400,486 persons.

Money, Weights, and Measures and their equivalents.

Gold.—1 Kilogramme of standard gold is coined into 155 Napoleons or 20 franc pieces.

1 Gold Napoleon or new Louis = 16*s.* 2*d.* Eng. = $3.86 U. S. = 20 francs.

1 Livre = 1 sovereign = £1 sterling, = 24 francs 76c. = $4.84 U. S.

Par value in London of £1 sterling = 25 francs 57 cen.

Silver.—1 Kilogramme [one-tenth alloy] is coined into 200 francs.

250 Francs of the Paris mint are equal to 100 Sicca Rupees.

1 Franc = 9*d.* 69*dec.* Eng., generally estimated at 10*d.* = $0.19⅜ U. S.

The franc is divided into 10 decimes = 0*d.* .969 each. 100 centimes = 0*d.* .0969 each.

5 Franc piece = 4*s.* 04*dec.* Eng. currency = 4*s.* 8*d.* Canada currency, = $0.97 U. S.

1 English sovereign = 24 francs 76 cen.

1 English shilling = 1 franc 16 cen.

5 Shilling-piece = 1 crown = 5 francs 80 cen.

1 United States dollar = $1.00 = 5.18 francs = 4.16 Eng. shillings.

1 Million of francs = £40,000 = $193.500.

Weights.

1 Kilogramme = 1000 grammes = 2 lbs. 3 oz. 4½ dr. Eng. = 2 lbs. 204 dec. avoir.

1 Gramme is the 1000th part of a kilogramme.

1 Livre usuelle or French pound = 500 grammes = 1 lb. 1 oz. 10¼ dr. = 1 lb. 1 dec. = 7717 English grains.

1 Metrical quintal = 0 ton 0985 = 220 lbs. =486 dec. English

10.1465 Metr. quin. [of 100 kilog.] = 1 ton English =2240 lbs.

1014. 65 Kilogrammes = 1 ton Eng. = 10.146 metr. quintals.

1 Metrical tonne = 1000 kilogrammes, for coal, 10 metr. quintals = 20 German centners or quintals.

1 Metrical tonne = 2207 lbs. English.

1 Ton English = 10 quin. 15,940.
1 Metr. quin. Eng. =0.09843.

Measures of Length.

1 { Pied usuel = foot 1 inch 122 dec. = 1-6 of 1 toise.
French foot = 3.048 decimetres = 12.78 Eng. inches.

1 French metre = 3 feet 3 inches 37 dec. = 39 in. 371 dec. = 3 feet 28 dec. Eng.

1 Centimetre = 0.39371 inches.

1 Decimetre = 3.9371 inches.

1 Decametre = 32.809 feet.

1 Hectomètre = 109 yards 1 foot 1 inch.

1 Kilomètre = 10 93 yards 633 dec.

161.024 Kilomètres = 100 English miles.

1 Myriamètre = 10, 936 yards, 330 dec. = 6 miles 1 furlong, 28 poles.

1 English mile = 1.6 kilometres; 3 English miles = 4.8 kilometres; 5 English miles = 8.0 kilometres; 10 English miles = 16 kilometres; 20 English miles — 32 kilometres; 25 English miles = 40¼ kilometres; 30 English miles = 48 kilometres; 40 English miles = to 64 kilometres; 50 English miles = 85½ kilometres; 60 English miles = 96 kilometres; 70 English miles = 113 kilometres; 80 English miles = 129 kilometres; 90 English miles = 145 kilometres; 100 English miles = 161 kilometres.

1 English mile = 1640 metres.

1 Toise usuelle = 6 feet 6 inches 735 dec. = 6 metres 57 dec.

1 Aune usuelle = 1 yard 3 dec. Eng. = 3 feet 11¾ inches Eng.

1 League = 2000 toises = 2 miles 743 yards = 4263 yards English = 3898 kilom.; 36,214 leagues = 100 English miles.

Measures of Capacity.

1 Litre is a cube of which the side is 1-10th of 1 metre = 1.763 pint =0.264 gallon.

1 Decalitre = 2 gallon 1 pint 60 dec.

1 Hectolitre = 90 kilogrammes = 2.838 bushels = 3½ cubic feet = 22 imperial gallons.

11.26 Hectolitres = 1 ton English.

1 Wheel-barrow load = ¾ of 1 hectolitre = 150 lbs., nearly.

1 French Boisseau usuel = 0.354 English bu

1 London chaldron = 25½ quintals or cwt. = 1295 kilog. = 17.26 hectolitres.

1 Newcastle chaldron = 53 quintals or cwt. = 2991 kilog. = 36 hectolitres.

1 Muid = 1.124. hhds.

Measures of Solidity.

1 Stere = 1 cubic metre = 35.3174 cubic feet English, for stone, peat, timber, &c.

1 Deci-stere = 3.53 cubic feet.

1 Deca-stere = 353.174 cubic feet.

1 Corde of wood = 2¾ steres = 97 cubic feet; but with local variations.

1 Banne of charcoal = 50 cubic feet.

1 Cubic metre = 35.31 English feet cube.

A stere of wood, produces on an average, 68 kilogr. 40 of charcoal.

Measures of Area.

1 Arpent of land = 1.043 acre.

1 Are of land = 0 rood 098 dec. = about 1-40th of 1 acre = 100 square metres.

1 Hectare = 2.471 acres = 11,960 square yards = 10,000 square metres.

4.046 Hectares = 10 acres English = 100 acres French.

1 Square kilometre = 0.386 English square miles = 1,196,044 square yards.

1 Square mile English = 3,097,600 square yards English.

Rules.

To reduce French kilogrammes to English pounds, multiply by 2.205.
" " quintal metriques to English pounds, multiply by 221.
" " quintals to English pounds multiply by 113.37.
" " metres to English pounds multiply by 39.375.
" " cubic metres to English cubic feet multiply by 35,32.
" " grammes to English grains multiply by 15,4340.
" " loths to English pounds multiply by 0.032,208,435.

In entering upon so important a section of our work as that which treats on the mineral combustibles of France, we conceive we cannot more appropriately commence that task than by citing an introductory passage, on that subject, by M. Burat, an eloquent French geologist. He remarks that "of all the circumstances which have been developed by researches beneath the surface of the earth, none have greater importance than those which result from the abundance of the mineral combustibles.

"Coal is now an object of immense industrial activity and of enormous wealth. If it be situated near a port, an army of miners excavate it, and hasten it to a distance. If placed in the interior, or in an isolated position, it collects around it the most multifarious manufactories.

"We have seen, even since the commencement of the present century, Manchester and Saint Etienne arise and increase. We have seen Swansea, also, her poetical name is as nothing in her prosperity. Formerly, under her first parentage, she was unknown: she is now the great city of the smelters and founders. She sends out her fleets to double Cape Horn, and to bring back the minerals of Chili. It is for her, to enrich her nobles, that the negroes of Cuba and the free population of Coquimbo or La Paz, labor; and it is solely to coal that she owes this power, which, one day, Provence and the Asturias will dispute with her, when they shall have recognized all the true value of their combustibles.

"England, so richly endowed with raw materials—a country enjoying such rapid and easy modes of communication—so indented in the lines of her coasts, that no land possesses such numerous sea-ports,—England holds with vigour the sceptre of industry and commerce. How can a supremacy be attacked which is supported by 1,570,000 hectares of coal lands, and by a production of 340 millions of quintals: whilst France scarcely produces more than a tenth of this quantity, and all the combined resources of Europe and the United States barely a third? If, then, we must resign to the English the sceptre of foreign commerce, we ought still to strive for a little of

that esprit, so eminently industrial, which distinguishes them; a little of that commercial science which would enable us to reap a larger portion of the mineral riches which we possess. We should aim, at least, to precede the other countries of Europe whose productive power is increasing and developing, and if we must yield the precedency to England, let it not be without an intelligent struggle, and not without acquiring, after her, the most honourable rank.

"To attain this result, it is best not only to ascertain well our own resources, but to study those of neighbouring countries. Such is the aim of our studies in relation to mineral riches: it will be well accomplished if they can aid in the development of our productive forces, and inspire our miners with a desire to emulate our neighbours."

HISTORICAL SKETCH OF THE DISCOVERY, PRODUCTION, AND CONSUMPTION OF MINERAL COMBUSTIBLES IN FRANCE.*

It is not known, with any certainty, at what period the employment of mineral fuel originated in France. The edict of Charles VI., dated 30th of May, 1413, the first official muniment known relating to the legislation of the mines, has principally for its object the mines of lead, copper, and silver, then worked in France, and makes no mention of coal.

Nevertheless, one would be inclined to think that this substance, which, for more than two centuries previously, had attained importance in the coal basins of Newcastle in England, and of Leige in Belgium, could not be unknown in France. Some traditions lead to the belief that the first indigenous operations were directed on the out-crops of the excellent beds of coal at St. Etienne and Brassac; and that the coals of Newcastle had been already imported, in the course of the fifteenth century, at several points along the maritime frontier of this kingdom.

The first attempts which were made to establish in Paris the use of this mineral combustible, extends back towards the year 1520; and it appears that it consisted of coals imported from Great Britain, by the Basse-Seine. It is, at least, so shown by the result of an inquest made at this epoch; in which the faculty of Medicine of Paris had to decide whether the employment of this new description of fuel from England would be prejudicial to the public health and salubrity. More than two centuries prior to this, a similar alarm was experienced in London: and the inquiry led, in 1306, to a royal proclamation against its use.

Coal [charbon de terre] is cited for the first time in 1548, along with several mineral substances, not metallic, in a request addressed to Henry II. by Jean Francois de la Roque, Lord of Roberval.

One would think that, if he comprised mines of coal in the number of those of which he obtained the concession, on the 30th of September of that year, that this fuel had already acquired a certain degree of industrial importance in France. In a succeeding page we shall show that the rights of the lords in coal lands had been long previously exercised.

Half a century later, the government perceived the utility of encouraging, by especial means, the "exploitation" of the mineral combustibles. We know, in fact, that by his edict of 1601, Henry IV. exempted stone-coal

* This article is chiefly based upon the "Resumé des travaux statistiques de l'administration des Mines, Paris, 1839, and subsequent returns.

from the ground rent of the tenth due to the sovereign, by virtue of his royal right and prerogative.

It appears that this edict gave a certain impulse to the researches and explorations for coal. Several documents, published in the first half of the seventeenth century, made known to France resources of which she had, until then, been ignorant; and pointed out the existence of coal in the environs of Vigan, Alais, Saint Gervais, Rongan, Ahun, &c. Some local traditions also give us reason to believe, that there already existed, towards the middle of the seventeenth century, regular extractions or pits of this combustible from the basins of La Loire, Brassac and Decize.

Tariff Laws, as regards the introduction of Coal.

The progress of coal operations, at home, and of the importations of foreign coal, after the close of the seventeenth century, from abroad, brought on the commencement of that struggle which has continued even to the present day; and which, even at this moment, gives rise to grave debates. It is, beyond doubt, to a rivalry of this nature must be attributed the edicts of 1667 and 1692; which imposed duties, to the amount of from 0*fr.* 97 to 1*fr.* 21 per 100 kilogrammes, [equivalent to 7*s.* 10*d.* sterling, or $1.87 American currency per ton, in the first case, and 12*s.* 9*d.* or $2.33 in the last,] on foreign or imported coals. It appears that these protective measures, and the war which commenced, towards the latter epoch, between France and England, suspended the importations of coal from the latter; and thus gave an active impulse to the collieries of Brassac, which were enabled to send from thence their products, along that valley, by the canal of Briare.

In 1703, causes, analogous to those which are even now experienced, determined the government to reduce the duty to 0*fr.* 33 per 100 kilogrammes, or 2*s.* 8*d.* sterling=$0.63 per English ton, in favour of the coals imported by the frontier of Belgium. But this exclusive arrangement, after having been a long time in force, was withdrawn, in 1763, by a decree; the object of which was, without doubt, to favour the early developments of the collieries of the north. This decree re-established the tariff of 1692, as regards the coals imported by land, and on the contrary lowered to 1*fr.* 10*c.* or 8*s.* 10*d.*=$2.12 per ton, the duty on coals imported by sea.

At length, an ordinance of 1764, which may be regarded as the origin of the commercial distinction of Zones, for all coals imported by sea, reduced further this duty to 0*fr.* 83*c.*=6*s.* 8*d.*=$1.60 per ton, for the maritime arrondissements of Bourdeaux and Rochelle.

Concessions for working Coal, and rights of Lords of the soil.

An edict of 1698, originating, like that of 1601, in the intention to foster the home trade, had an entirely opposite result. In authorziing the proprietors to work the coal existing under their individual estates, without the permission of the lord of the soil, the ordinance had the unfortunate effect of withdrawing this branch of industry from all surveillance: to deliver to the incompetent miner precious riches; and, above all, to take from the lord [souverain] the power of placing his interests in the most fitting hands.

In 1774, an ordinance of Louis XV. annulled that of 1698; and once more placed coal among the number of those mineral substances which could not be mined without a concession or grant from the lord.*

* Resumé des travaux statisques, &c., Paris, 1839.

From a recent memoir of M. Manés, it is shown that the existence of coal within the basin of Blanzy has been known from a very early period. The registers "*terriers*" of Plessis in 1528, of Ocle at the same epoch, of Montcenis in 1610, and of Torcy in 1640, establish the rights of the lords over those lands which contained coal. These terriers are the more remarkable inasmuch as they show the exorbitant claims of the lords, which amounted to one-third, and sometimes two-thirds, of all the coal extracted.*

We shall, in another part of this work, indicate the points where early coal-works were established.

We will only add, in brief, that researches commenced at Anzin in 1719.

In 1730, was discovered the coal basin of Hardinghen.

In 1734, the first extraction of coal took place in the basin of Creusot.

In 1735, that of the basin of Brassac was organized.

In 1737, the first regular workings in the basin of the Loire.

In 1740, in the basin of Decize, followed by many other local coal operations.

Area of surface occupied by Coal formations in France.—According to the excellent elementary treatise on geology, by M. Beudant, the known coal formations form, in France, less than 1-200th part of the superficies of the territory.† We have reason to know that this estimate is greatly under-rated, and that the proportion is at least 1-117th part of the area of France, if we take the aggregate of the concessions for working coal, without including the lignite beds and anthracite.

The area of all France is	130,391,255	English acres.	
In 1840 the area of the concessions was then	1,080,503	"	"
In 1845 it amounted to	1,113,550	"	"

The first proportion was 1-121=1688 square miles. For the coal and anthracite the proportion in 1845 was 1-117th of the whole.

This quantity is annually increasing, as new mines are opened and further discoveries are made. In 1842 the amount of concessions was 433,-403 hectares,=1,070,940 acres.

In 1843, the area of the 399 concessions in the carboniferous basins of France, was reported to be 447,326 hectares,=1,105,342 English acres, being 1-117th part of the entire area of France, or 1719 square miles of concessions, exclusive of anthracite and lignite.

In 1845, the area of 412 actual concessions—459,551 hectares,=1,135,-550 acres, or 1-114th part, or 1774 square miles, besides 1106 hectares not definitely conceded.

The bituminous and non-bituminous varieties of coal, anthracite and lignite, exist in eighty-eight principal basins, besides a great number of small detached coal-fields or deposits, less perfectly known, and occur in fifty-six out of the eighty-six departments of France.

The production in France cannot be estimated at less than four millions of English tons; while so late as the commencement of the French Revolution, all France yielded only 240,000 tons; the greater part of which production was limited to two principal coal-fields.

At that period, also, France received from abroad full as much coal as her own soil yielded. Now, although the indigenous production has advanced from that period to the present,—a space of fifty-six years,—at the enormous rate of upwards of seventeen hundred per cent., and her importations have increased seven hundred and ninety-two per cent., the quantity of

* Annales des Mines, 1843, Vol. IV. p. 486.

† Geologie—par M. F. S. Beudant.

imported coal is more than one half of the entire amount of native production.

As regards the general *quality* of the coal of France, it is now admitted that it is of an inferior description, and not to be compared with that of Newcastle, Durham, Sunderland, Staffordshire, Wales, and Ireland. Consequently, where good strong coals are required, it is to the mines of those districts, that the French government and private companies resort for their supplies. It is the scarcity and dearness of coal and wood, in France, notwithstanding her extensive mines and forests, and the enormous expense of carriage, that form the chief drawbacks to mining generally, and other great undertakings in that country.* Even the national steam marine of France derives its chief supplies of coal from Great Britain.

As to the employment of the mineral combustible in France, it is now remarked that it has greatly increased of late years. A recent writer has observed, in 1848, that "coal is getting more into favour with the French, every day. A few years ago, you could scarcely meet with a single coal fire in any house in Paris. Now, coal fires are no novelty; and yet the only coal the Parisians are able to procure, is both dear in price and detestable in quality. English coal finds its way into thirty-eight departments; whilst that of Belgium goes only into twenty-six.†

Geological phenomena attendant on the principal coal basins of France.—At the basin of Creusot, the coal occurs in argillaceous schist, alternating with granitoid psammites, as in the coal-field of Richmond, in Virginia, and in northern Hindostan.

In, or upon granite, between Ebreuïl and Charbonniers, in Auvergne: Anthracite

In or upon gneiss, at Venosque.

In a deep basin of gneiss, at the coal basin of Brassac.

In schist, at Oris; department of Isére.

In limestone, at Wehran, in Alsace.

In the gneiss and talcase schist formations; departments of Isére and Hautes Alpes, overlaid by the lias, or Jura formation.

In limestone not older than the oolite, in Savoy: anthracite.

The coal basin of the Sornin lies along a trough of granite.

" " of Labourbince rests upon granite, gneiss, porphyrites and eurites.

" " of Arroux is bordered to the S. and E. by granite and gneiss, and to the N. and W. by porphyries and eurites.

" " of Valenciennes and Belgium, is overlaid with the chalk formation, from 20 to 140 yards thick.

" " of La Dhun, covers gneiss, leptinite and phyllades, and is covered by the sandstone of the Leas.

" " of Sincy is enclosed by granite and gneiss.

" " of Autun and Epinac rests upon porphyries, eurites and trap, on the north; on gneiss, amphibolites and leptinites to the south and east, and on granite to the west.

" " of Argental, [Corrèze] is placed upon mica schist.

" " of Creusot and Toulon, rests upon the silurian series.

" " of Rive de Gier, rests upon mica schists and talcase schists.

" " of Saint Barbe, [Maine et Loire] is intercalated with beds of feldspathic sandstone.

* Mining Journal, Jan. 3, 1846. † Correspondent of the Mining Journal, Jan. 1, 1848.

The coal basin of Blanzy occurs in a gneiss valley, almost vertically, between beds of argillaceous schist; alternating with granitoid psammites.

" " of Pas de Calais, is surrounded by a zone of chalk.

" " of Ronjan, [Herault,] reposes on transition schists, and is covered by tertiary strata.

" " of Vouvant, [Vendée,] reposes upon transition schist.

" " of Hardinghen and Fiennes, is, in part, worked within the limits of the overlying chalk.

" " of Du Nord, is worked through the tertiary and cretaceous formations. Its lower beds include the whole of the Devonian system of England.

" " of Bretagne, in the silurian system.

" " of Bourg-Lastic, [Puy de Dôme,] is surrounded by primary rocks.

" " of Basse Loire—upper part of the transition series.

" " of Meimac, [Corrèze,] is enclosed in porphyroid granite.

" " of Langeac, [Haute Loire,] in primitive rocks.

Gypseous coal of the Vosges, in the red marl.

Basin of Sainte-Foy-l'Argentière [Rhone] rests immediately on beds of gneiss and micaceous schists.

" Fins et Noyant [Allier] reposes upon granite, a depression of which it fills.

" Ahun, [Creuse] consists of strata which are re-composed from the debris of granite rocks—psammites.

We may note also, that the anthracite near Oporte, in Portugal, is interstratified with granitoid psammites, and is covered by chlorite slates.

FRANCE.

Concessions or Grants—Royalties or Annual Rents of Coal Mines.

Under one or other of these heads we have furnished a few notices of the methods in common use in South Wales, in England, Scotland, Bohemia, &c. We pursue this important subject as it relates to the colliery arrangements of France.

In France, the concessions, which of course are derived from the crown, in the first instance, frequently comprise a large area of mineral land; they are unlimited as to their depth, and also as to their superficial extent.

It is unusual to grant more than a single concession in the same coal basin, to the same individual, but they are often of great size. Thus, the basin of Litry forms but a single concession of 11,586 hectares, or 28,630 English acres.

The usual form of the Royal *Ordonnance*, giving a concession of certain

mines, whether of metallic ores, or of coal, anthracite, or lignite, to the parties therein named, contains a description of the boundaries of the lands granted: the quantity comprised within those limits, and the rent and conditions imposed on the lessee; who moreover is bounded by the general laws that apply to the mining concerns of the country.

Thus, in the Ordonnance, 26th March, 1843, conceding the anthracite mines of *Charbonniere*, in the Commune of St. Symphorien de Lay, Department of the Loire, the grantees are bound,

1st. To pay to the proprietors of the surface, an annual rent of ten centimes per hectare, which is about one penny English, or two cents American, for each two and a half acres: on all the lands comprised in the concession.

2nd. And a ground-rent, for the benefit of the proprietors, arising from a proportion of the produce of those lands in which works shall be carried. This ground-rent is fixed, whatever may be the thickness of the coal seams;

At the twentieth [20th] part of the total produce of the workings, (exploitation,) so long as the depth shall not exceed 100 metres=328 feet Engl.

At the fortieth, [40th] of the same produce, from the depth of from 100 to 200 metres;=328 to 656 feet Engl.

And at the sixtieth [60th] part, for all depth beyond 200 metres.

This rent or tribute shall be delivered in kind, as fast as, and in accordance with, the extraction; unless the proprietary shall prefer to receive it in money. In that case, it shall be paid weekly, according to the value of anthracite, and according to an amicable decision, or to that of a jury.

The proprietary shall declare to the lessees in what way they intend to receive their rent. That declaration shall form the rule, even unto the abandonment of the bed in work; to the moment when it shall be terminated.*

Wherever, in the progress of the subterranean operations, the works approach near to any road or canal, or to any village or town, authority to proceed must be obtained from the prefect, who decides according to the official reports of the engineers; and the mayor of the commune, the municipal council, and the proprietors interested.

The lessees of the mine must first give a bond to indemnify for damages that may be sustained. This authority may be withheld by the prefect, if he is assured that the works would compromise the security of the surface, the safety of the inhabitants, or the preservation of their edifices; or in case of passing under a canal or river, that it would be impossible to preserve the mine from inundation.†

Concession of the anthracite mines of Bully and Fragny, [Loire] 11th July, 1843.—The same conditions and annual rents are imposed as in the above cited concession of Charbonniere: also in those of Jœuvre and Bruyere.‡

Concession of the Coal Mines of La Sibertière [Loire.]

In this example, the royal ordinance, after defining the area, fixes the annual rights or rent, accruing to the proprietors of the surface, according to the produce of the mines. This ground rent, which the concessionaries are to pay to the proprietors, are thus fixed:

* Annales des Mines, Vol. III. 1843, p. 905. † Ibid. Vol. XIX. p. 785—793.
‡ Ibid., Vol. IV. 1843, p. 700.

Table of the Rents or Proportions to be paid to the Proprietors of the surface, by the Concessionaires or Grantees.

Vertical depth of ground explored proportionate to the depth and cost of sinking shafts and galleries.	Thickness of coal beds.			
	6 feet and upwards.	6 feet to 3 feet.	3 feet to 1½ feet.	below 1½ feet.
Open work, from the surface, -	$\frac{1}{4}$	$\frac{1}{6}$	$\frac{1}{8}$	$\frac{1}{16}$
By pits extending down to 150 feet,	$\frac{1}{6}$	$\frac{1}{9}$	$\frac{1}{12}$	$\frac{1}{24}$
From 150 to 300 feet, - -	$\frac{1}{8}$	$\frac{1}{12}$	$\frac{1}{16}$	$\frac{1}{32}$
300 to 450 feet, - -	$\frac{1}{10}$	$\frac{1}{15}$	$\frac{1}{20}$	$\frac{1}{40}$
450 to 600 " - - -	$\frac{1}{12}$	$\frac{1}{18}$	$\frac{1}{24}$	$\frac{1}{48}$
600 to 750 ". - - -	$\frac{1}{14}$	$\frac{1}{21}$	$\frac{1}{28}$	$\frac{1}{56}$
750 to 900 " - - -	$\frac{1}{16}$	$\frac{1}{24}$	$\frac{1}{32}$	$\frac{1}{64}$
Below 900 " - - -	$\frac{1}{20}$	$\frac{1}{30}$	$\frac{1}{40}$	$\frac{1}{80}$

In fixing the thickness of a bed of coal, it is understood that it expresses the aggregate of the separate layers of which it may be composed; deducting any interposing seams of slate or rock: provided that those seams extend for at least three hundred square feet, and that they have a mean thickness of four inches and upwards.

The proprietor's share of produce shall be delivered day by day, unless they prefer to receive the value in money, according to the current price of coal in the neighbouring concessions.

When the proprietors have once declared their choice as to the payment of their share, whether in kind or in money, it is obligatory on them to continue that arrangement, until the abandonment of the bed in operation.

When the works shall have proceeded to within the distance of not less than thirty-three feet of the Royal road from Lyons to Saint Etienne, [which crosses this concession,] the mine shall not be proceeded in, unless by virtue of a special authority from the prefect, given under the reports of the engineers of mines and of the engineers of roads and bridges.

The openings into the pits or galleries which become useless are to be solidly filled up, or closed by the concessionaries, at their expense; according to the mode which shall be prescribed by the prefect, under the advice of the engineer of the mines, and the inspection of the mayors of the communes wherein the mines are situated.*

Various modifications of the terms of these concessions are adopted, according to local or other circumstances. Whether this excessive legislation operates in the end, either in favour of mining industry and for the general benefit of the community, or the reverse, is a question which we shall not discuss here.

For example, in the ordinance, 11th September, 1841, making concession of the anthracite mines, *Minès des Mays*, in the commune of Mont-de-Lans, department of *Isère;* by the sixth article, the concessionaries are compelled to deliver to the inhabitants of the said commune, the quantity of anthracite necessary for their fuel, at a price which is not to exceed seventy-five centimes,=7¼ pence per 100 killogrammes,=220,486 lbs. This price is equivalent to 6*s.* 2*d.* English,=\$1.49$\frac{2}{10}$ per ton, of 2240 lbs. English, taken at the mouth or floor of the mine.

At the end of five years, the price above named, will be revised and fixed

* Annales des Mines, 1841, Vol. XIX. p. 778.

anew by the prefect of the department, acting on the report of the engineers of mines, after the grantees and the municipal council shall have been heard.*

Similar terms as to price of anthracite to be delivered to the inhabitants of the commune of Mont-de-Lans, in Isère, is provided in the ordinance for the concession of La Molliere.

In the concession of "*Côte-Oliviere*," commune of the *Argentiere*, department *Hautes Alpes*, the lessees are bound to deliver, to the inhabitants of that commune, all the anthracite requisite for their domestic wants, at the price of 40 centimes per metrical quintal; which is equivalent to 3*s.* 3½*d.* =$0.79 per ton of 2240 lbs.†

In another case, that of the coal mines of *Vicoigne* arrondissement of *Valenciennes*, department of the North, the grantees are civilly held responsible for damage committed in the forests, by their workmen and cattle. When the grantees shall abandon an opening of a mine, they shall fill it up and level the ground, and shall replant on the surface, the trees adapted to the soil.‡

In the concession of the mines of lignite of *Labrugière*, arrondissement of *Castres*, department of Tarn, the concessionaries are to pay to the proprietors of the soil, 1st. A ground or quitrent of 5 centimes per hectare, = 0 penny 0.5 = 0 cent 1 per English acre. 2nd. A payment or royalty of a *fiftieth* part [50th] of the value of the produce of the mine, to the proprietors of the land on which the extraction is made.§

Some of the ancient concessions were taken on lower terms than those of modern times. That of the coal basin of Decize, in 1740, was obtained on payment of about 7 centimes per 100 kilogrammes of coal raised. This is equivalent to about 3 farthings sterling, or 1⅓ cent per ton.

Occasionally royal ordinances are passed, to change or remit certain rents; as, for instance, that of 24th September, 1843, to exempt from payment of the proportional ground rent, during three years, the coal mines of La Tapie and Lhermie [Aveyron.]||

For authority to undertake works of research and of exploration for coal or other mines, the ordinance usually imposes conditions, and limits the duration of those powers, generally to about two years.

By three ordinances, in the year 1843, conceding the mines of bituminous schist of Millery, of Surmoulin, of Dracy St. Loup, [Saône-et-Loire] the terms are fixed at 1st, the usual annual rent to the proprietors of 10 centimes per hectare; 2d, a ground rent or royalty of $\frac{1}{20}$th of the minerals extracted, so long as the works are open to the sky, and $\frac{1}{40}$th when the operations shall be carried beneath the surface.

Precisely similar terms are prescribed in seven grants of bituminous limestone and sandstone mines in Puy-de-dome, &c. during the same year.

Revenue derived by France from the fixed rents and per centage of all the mines and mineral possessions.—In 1844, £369,903. In 1845, £430,868.

Colliery Regulations in France.

On the 1st of January, 1846, an order issued by the Prefect of Montbrison, for the observance of the following notice, regulating the working of coal mines, went into effect.

I. That all the *concessionaries* and workers of the mines send in to the office of the Engineer of Mines, at St. Etienne and Rive de Gier, the plans and

* Annales des Mines, 1841, Vol. XX. p. 705.
† Ibid. p. 708.
‡ Ibid. tome XVIII. p. 805.
§ Ibid. p. 709.
|| Ibid. Vol. IV. 1843, p. 722.

sections of the works, which they have executed during the preceding year. These plans and sections must be drawn with great care, on the scale of one millimetre [or 1000th part] per metre, or three feet. The subterraneous works appertaining to different beds or seams, must not be described on the same sheet of paper, but be placed one upon the other; and they must be distinguished by particular tints, but well drawn, separately.

II. Directs returns to be made of the number of workmen; of horses; of machines, or steam engines; the amount of rough production; the price of each quality of coal; the total value produced; the expenses of the workings; and the profits or losses experienced.

III. The neglect of attention to Art. 1 and 2, authorizes the seizure of that portion of the mine of which the plans sent in are incorrect, besides the liability of an action by the correctional police.*

Government engineers on full pay in France, in 1846, 722; engineers of mines, 109. Total, 831.

Note.—Until the year 1840, the official returns of combustible fuel annually produced in France, were arranged under the triple division of bituminous coal, anthracite, and lignite, as shown in the columns* of the preceding table. This division, however, had the inconvenience of confounding, under the general denomination of *coal,* varieties which materially differed in their uses and properties.

Since 1840, the mineral combustibles have been distinguished in six categories, as this new arrangement is more conformable to the present state of science, and to the uses to which these fuels are applied. We have not thought necessary to alter our previous arrangement, nor is it, indeed, quite practicable, but we give, here, in the table below, the method which is now substituted, by way of showing the respective proportions of each, as seen in the returns for the four years, from 1843 to 1846, inclusive, in metrical quintals of 10.1465 to 1 ton, English.

Production of Mineral Combustibles in France.

Subdivisions of Coal.	1843. Metrical Quintals.	1843. Maximum propor. of carbon, per cent.	1844. Metrical Quintals.	1845. Metrical Quintals.
1. Anthracite,—not yielding coke,	5,744,158	90	5,799,240	5,784,722
2. Hard coal, short flame, - -	1,651,512	75	2,290,433	2,739,602
3. Gaseous or forging coal, -	3,962,397	60	3,755,624	5,618,779
4. Gaseous coal, long flame, -	19,418,167	60	19,617,330	19,295,048
5. Small coal, long flame, -	4,812,314	60	4,883,997	7,030,444
6. Lignite, stipite, &c. - - -	1,336,848	40	1,480,771	1,552,324
Total annually extracted,	36,925,396		37,827,395	42,020,919
Peat or turf, - - - - -	4,542,760			5,201,824
Total of indigenous fuel,	41,468,156			47,222,743

Value of Production of the Coal-fields of France.

Statement of the annual or periodical value, at the pit's mouth, of indigenous combustible minerals, viz. coal, anthracite, and lignite or brown

* Mining Journal, January 3, 1846.

coal, exclusive of turf, raised in France, calculated in French, English, and American currencies.

Value at the place of production.							
Years.	French Cur. Francs. 19¼ cents each, U. S.	English Currency, at 9d. 69.	U. States Currency.	Years.	French Cur. Francs. 19¼ cents. each, U. S.	English Currency. at 9d. 69.	U. States Currency.
1814	6,802,447	£ 272,097	$1,316,950	1838	29,078,083	£ 1,174,027	$5,620,800
1817		360,615	1,745,380	1839	29,005,601	1,171,101	5,599,000
1820		395,405	1,913,760	1840	29,284,052	1,182,343	5,681,100
1825		517,621	2,505,280	1842	33,497,779	1,352,472	6,476,230
1830		622,939	3,015,020	1843	34,416,570	1,364,257	6,539,140
1832	16,079,670	643,186	3,062,700	1844	35,497,000	1,507,929	7,220,630
1834	23,649,145	996,160	4,493,330	1845	39,705,432	1,603,106	7,663,000
1836	26,607,071	1,064,282	5,143,150				

To these may be added the value of the turf raised.

In 1845, 5,065,022 francs, making the entire value of the combustibles 44,770,554 francs.

Production of Mineral Combustibles in France.—Abstract of the Collieries of France.

The following table shows the number of concessions or mines, worked and unworked, their areas and production at given periods; together with the number of workmen, of steam-engines and of horse power, employed in the mines of *coal, anthracite, and lignite*, throughout France: exclusive of peat or turf.

Years.	Total number of mines worked and unworked.	Area of surface occupied by mines.			Steam Engines.		Number of workmen.	Annual production.
		Conceded hectares.	Provisional hectares.	Total in English acres under grants.	No.	Horse power.		English tons of 10.14 metr. quintals.
1830				692,000				1,836,950
1834	200			742,437			17,218	1,962,085
1835	320				267			2,471,800
1836	258						21,913	2,635,350
1837	341	396,663	2,679	986,773			22,837	2,948,000
1838	359	409,204	5,628	1,011,143	323	7,006	26,216	3,070,260
1839	364	420,962		1,050,688	369	8,373	26,966	2,994,860
1840	378	428,251		1,080,503	396	9,540	27,754	3,148,500
1843	399	447,326		1,105,342	396	10,000	29,500	3,639,446
1844	425	450,000			396	10,189	29,554	3,728,306
1845	449	459,551	1,106	1,113,550	391	10,129	30,778	4,141,617

Maximum depth of the shafts in 1845 = 1600 feet or 519 metres.

It must be remembered that the superficial areas of concessions, returned in the foregoing table, do not define the entire areas of the French coal-fields: they merely denote the quantities of land held, from time to time, under the royal grants.

Table of the mean prices at the pit's mouth, or cost of production, of bituminous coal, anthracite, and lignite, in the principal basins of France, in the years 1839, 1842, and 1845; in French, English, and American

currencies; arranged according to the relative importance of the respective basins, from the *Conte Rendu des travaux*, 1846, &c.

Names of Basins.	Departments.	Mean price per ton.				
		1839.	1842.		1845.	
		Fr. C.	Fr. C.	Doll's.	s. d.	Doll's.
Loire, - - -	Loire, Rhone, Isère,	8 70	7.60	1.46	6.2	1.60
Valenciennes, - -	Nord, - -	13.00	10.60	2.04	10.0	2.40
Alais, - - -	Ardeche, Gard,	10.20	7.20	1.39	5.7	1.35
Creusot and Blanzy, -	Saône et Loire, -	8.70	9.40	1.82	7.3	1.68
D'Aubin, - - -	Aveyron, -	5.00	5 20	1.00	6.0	1.45
Epinac, - - -	Saône et Loire, -	9.40	9.90	1.91	7.6	1.81
Littry, - - -	Manche, Calvadas,	14.50	11.60	2.24	12.2	2.94
Commentry, Doyet and Bezonet,	Allier, - -	8.40	6.90	1.31	5.11	1.43
Brassac, - - -	Puy de Dôme, Haute, Loire,	9.80	8.60	1.66	5.10	1.41
Basse-Loire, - -	Loire, Inférieure, Maine et Loire,	21.70	19.90	3.85	17.3	4.17
Decize, - - -	Nièvre, - -	11.20	10.40	2.01	10.0	2.40
Carmeaux, - -	Tarn, -	16.50	15.70	3.04	12.5	3.00
Saint-Gervais, - -	Herault, - -	10 40	10 80	2.09	6.0	1.45
Hardinghen, - -	Pas de Calais,	15.40	14.60	2.82	11.11	2.88
Bert, - - -	Allier, - -	8.70	4.00	0.77	4.2	1.00
Sainte-Foy l'Argentiere,	Rhône, -	14.50	12.60	2 44	8.4	2.00
La Chapelle-saus-Dhun, -	Saône et Loire,		10.60	2.04	7.3	1.75
Average of all the coal, anthracite, and lignite basins of France, - - - -		11.63 $2.25	9.30	1.80 8d. 4s.	7.10	1.89

The foregoing official statement demonstrates that the price of coals at the pit's mouth is higher in France than in England, or even in the United States of America. The difference to the consumer of coal in France is still more apparent, when the high rates of transportation in that country are taken into the account.

Under the head of "*Expenses of transportation of coal,*" the authors of the elaborate work "on the fabrication of iron in France," show that several causes combine to maintain the high price of coal there, and consequently to have a corresponding influence on the cost of iron. Among these elements are, in the first place, the great distances which, in so extensive a country as France, very naturally separate the points of consumption from those of production;—again, the unequal distribution, over the surface, of the mineral products and the combustibles:—the bad position of manufacturing establishments in relation to the primary materials, by which they are supplied;—finally, and above all, the bad condition, and even the absence of the means of transport.

The writer adds, "we will give an idea of the imperfection of our system of transportation, [viabilité] by noting the fact, that the transport, and the accessory expenses, often augment the price of the coal in the proportion of *one to six*, and, on an average, *ten to twenty-three.* This average is, otherwise, too low, because it comprises the total of the combustibles extracted, of which a portion is consumed even upon the place of extraction, without having any new charges to heighten its cost."*

* Traitè de la fabrication de la fonte et du fer. Paris, December, 1845, p. 1062.

Prices of Mineral Combustibles.

Table of the average annual prices of coal, anthracite and lignite at the places of extraction, in the mining districts of France:—in French, English, and American currency, per English ton.

Years.	Bituminous coal prices per ton of 2240 lbs. At the place of production or pit's mouth.		Anthracite at the mine.		Lignite at the mine.	
	Fr. Cts.	Dollars.	Francs.	Dollars.	Francs.	Dollars.
1814	10.10	1.96	8.01	1.55	9.92	1.92
1816	10.46	2.03	8.60	1.67		
1826	10.56	2.05	9.80	1.90		
1830					9.82	1.86
1836	9.84	1.87	12.62	2.45		
1837	10.10	1.96	9.63	1.86	9.63	1.83
1838	10.30	2.00	14.00	2.72	9.13	1.77
1839	11.63	2.25	15.00	2.85		
1840	9.80	1.86	11.53	2.24	10.30	2.00
1841	11.44	2.22	13.80	2.66	9.00	1.74
1842	9.30	1.80				
1843	9.45	1.83				
1845	11.20	2.16				
Another account.	9.50	1.89	12.30	2.37	10.40	2.01

The prices of coal at the pit's mouth are higher in France than in England. Thus, while in France it is 7*s.* 9*d.* to 8*s.* 6*d.* per ton, [and even as high as 10*s.*] it is not more than half that price in Wales, and at the iron works, probably not more than 3*s.* The practical effect of this difference in the cost of coal may be seen in the price of the iron made in France, which is exorbitantly high, as compared with that of England. The great obstacle which the French iron manufacturers have to contend with, is the scarcity of fuel for their forges and smelting houses, in many districts. They will, probably, be obliged, for some years to come, to import their chief materials from England or Belgium, neither of which countries have, at present, much more iron than they require.

The following statement exhibits the increased demand for cast metal in France.

Pig Iron.—Quantity imported,	1841,	26,933 tons.	
" "	1843,	42,206 "	
" "	1844,	53,110 "	
" "	1845,	55,640 "	more than doubled in four years.

There is another source, however, to which at no very distant period, it is far from improbable, France may look for supplies of iron. We refer to the United States of America, and to Pennsylvania in particular, where the business of iron making is advancing with extraordinary rapidity; and where the surprising abundance of the raw materials, and the ample facilities of transportation, constitute advantages unsurpassed by any country.

Already the improvements in France, by canals and railroads, opening into the coal regions, have had a marked effect, in reducing the price of

fuel in certain localities. Thus, the Minister of Commerce states, in 1841, that coal which had been worth from five to seven francs at Mulhausen, had, since the opening of the canal from the Rhone to the Rhine, obtained only 3*fr.* 50*c.*=27*s.* 6*d.*= $6.65 per ton, and would be further reduced to 2*fr.* 50*c.* when the communications with Epinac are completed.*

Still, it will be difficult to compete, successfully and extensively, with the Newcastle or Welsh coal, in the ports of the Mediterranean. In the same year, 1841, the French post-office department effected their annual contract for sixteen thousand tons of coal; delivered in certain proportions, at Malta, Alexandria, Athens, the Isle of Syra, and Constantinople, for the government steam vessels, it being adjudged to Messrs. Jackson of London. There were four tenders,—three English and one Marseilles. The contract price was 4*fr.* 69*c.* per 100 kilogrammes=37*s.*=$8.91 per ton.

The government of France continues to make annual contracts for the supply of English coal for various steamboat stations. The Minister of Marine and the Colonies, gave notice of his readiness to enter into contracts, on the 12th of December, 1845, for eighteen millions of pounds of British coal, to be delivered at certain points on the western coast of Africa. And on the 24th of December, 1845, a further contract for five millions of pounds of British coal, to supply the French Islands of Papeiti and Taio-hae, in the [Society Islands] Pacific Ocean.† Similar announcements take place every few months.

In 1838, the prices of coal of all descriptions, viz., bituminous, anthracite, and brown coal, raised in France, were, at the mines or places of production, estimated at $2.72 per ton.

And the average price of the same at the places of consumption, in all France, was returned at $6.07 per ton.

In the previous year, 1836, the average price of coal, at 157 principal mining establishments, was $1.84 per ton.

In 1841, the great manufacturing city and port of Nantes was supplied with coal, from the interior, for $4.61 per ton.

A large company, in the district of the Loire Inferieure, offered to supply the same city that year for $4.68 per ton. That is, at $2.28 at the mines, and $2.40 for its transportation.

At Monzeil, also in 1841, price at the mines $2.40 per ton, or delivered 20 miles, $3.75.

Average Prices at the Pits.	Per Metrical Quintal in France.					
	1839.		1840.		1845.	
Coal Bituminous and anthracite,	0*fr.*	98*c.*	0*fr.*	98*c.*	1*fr.*	20*c.*
Lignite, - - - - - -	0	90	0	97	1	04
Anthracite, - - - - - -	1	38	1	52	1	23
Turf or Peat, - - - - -	0	88	0	91	0	97

We are indebted to the Mining Journal, and the excellent communications of its Paris correspondent, for many of the foregoing details.

Prices of Coal at the principal Basins of France, in 1845.‡

A commission has been appointed of the most scientific miners and geologists in France, to visit the different coal mines throughout the coun-

* History of Fossil Fuel, p. 453. † Correspondent Mining of Journal.
‡ Article in the Moniteur Industriel, translated in the Mining Journal, August 9th, 1845, with the editor's comments thereon.

try, and to adopt the best means of preventing the accidents that too frequently occur from fire-damp and the want of proper ventilation, and a thorough knowledge of the strata throughout which they have to work. There is a spirit of coal monopoly arising in France, similar to that of the principal coal mining districts of England, where they remain in the hands of a few landholders. Speculators in France have had full scope to carry out this important branch of industry, by forming wealthy companies—thereby establishing a monopoly that has tended greatly to injure the progress that might have been made by small capitalists, had they been able to compete against them, or obtain their ores and coal at a moderate rate. This monopoly has, therefore, had the worst tendency to depress the metallic manufactories of France, and the object of the newly appointed commission is to inquire into all the circumstances attendant upon this important subject.

The periodical consumption of coal in France, after deducting the quantity exported from the aggregate of domestic supply and foreign importation:

Years.	Metrical Quintals.	Years.	Metrical Quintals.
1813	8,500,000	1843	52,935,082
1823	14,000,000	1844	55,868,501
1833	27,000,000	1845	63,430,692

Increased consumption in thirty-two years, 646 per cent.

Expense of working Coal Mines in France.

The mine or bed of the Treuil, near St. Etienne, has been particularly reported on by M. Marrot. Its thickness is four feet, the inclination very inconsiderable, and the depth but trifling. The service of the mine is accomplished by two shafts, of which the machines of extraction also pump out the water.

The annual extraction is 300,000 hectolitres, or 26,000 tons. The expenses of mining this coal are 3*fr.* 50*c.* or nearly three shillings sterling, per ton, which does not include any interest for the capital invested.

The most profitable veins in the collieries of the north, those of Donain, with a thickness of near three feet, produce coal at 6*fr.* 46*c.* or 5*s.* 4*d.* per ton. The veins of Belgium, of the thickness of 3¼ feet, furnish it at 5*fr.* 20*c.* or 4*s.* 4*d.* per ton.

Official Tariff of the duties on coal in France, March, 1844.

			Per 100 kilogr. fr. c.	Per Eng. ton. *s.* .*d*	Per Eng. ton. U. S. Dollars.
COAL by sea	From the Sands of Olonne to Dunkirk, inclusive.	In French vessels	0 50	4 0	0.97
		In foreign vessels	1 00	8 0	1.93
	To all other points	In French vessels	0 30	2 5	0.58
		In foreign vessels	0 80	6 6	1.54
By land	From the sea to Halluin	do.	0 50	4 0	0.97
	By the Meuse and the Dep. of the Moselle	do.	0 10	0 9¾	0.19.3
	By all other points		0 15	1 2¼	0.29
Coke is double the duty on coals, in all cases.					

Table of French Import Duties on Coal.

	On British coals in British vessels per ton.		On Belgian coals per ton.	
	Sterling.	U. States	Sterling.	U. States.
	s d.	Dollars.	s. d.	Dollars.
In 1667, a duty on foreign [English] coal was imposed, of 0*fr.* 97*c.* per 100 kilogrammes, - -	7 10	1.87	7 10	1.87
In 1692, by edict, duty raised to 1*fr.* 21*c.* per 100 kilogrammes, - - - - - - - -	12 9	2.33	12 9	2.33
In 1703, lowered to 0*fr.* 33*c.* per 100 kil. on Belgian coals, and so continued until 1763, - -			2 8	0.63
In 1763, { Imported by land, - - - - -			12 9	2.33
{ Imported by sea, 1*fr.* 10*c.* per 100 kil.			8 10	2.12
In 1764, by sea to the ports of Rochelle and Bordeaux, - - - - - - - - - -	6 8	1.60	6 8	1.60
In 1778, the French import duty on British and Belgian coals, - - - - - - - -	6 11	1.66	10 1	2.46
Subsequently, we observe a duty of 10*fr.* per ton in French and 15*fr.* in foreign ships, - -	11 10	2.85		
In 1813 to 1834, the English duty increased, and Belgian reduced, to - - - - - -	13 9	3.33	2 9	0.66
In 1834, the duty on English coal was reduced to the British export duty in foreign vessels, exclusive of the customs, - - - - - -	8 0	1.90		
From 1834 to 1837, the actual duty on English coals received in the North of France was as follows:—Duty in ports between St. Malo and the Belgian frontier, per ton, 10*fr.* 0*c.* 10 per cent. on the duty levied by the customs, 10*c.* The Octroi duty, 3*fr.* 40*c.* Making the duties and customs amount in all to 13*fr.* 50*c.* - -	10 6	2.57	2 6	0.60
At the time this alteration took place, Newcastle coal was sold in France at 45*fr.* to 50*fr.*=$8.55 to $9.00 per ton.				
In 1837, by an ordonnance of Louis Philippe, the duties were reduced on coals imported into the ports between the Sables d'Olonne in La Vendée, to Dunkirk, to 1*fr.* per ton in French, or 5*fr.* in British vessels, - - - - - -	4 0	0.97		
The 10 per cent. custom duty, and the Octroi duty, remained; as also a charge of about 3*fr.* per ton to the custom houses for unloading.				
The alteration was for the purpose of giving the manufacturers on the Seine the advantage of a regular supply of coals.				
Paris, which had heretofore been exclusively furnished from the mines of Anzin and the Loire, imported this year a quantity of Newcastle coal, notwithstanding the high charges and the differential duty.				
Belgium, notwithstanding the monopoly afforded her by the French, was unable to supply either Paris, Rouen, or Havre, with the requisite quantity.*				
From this time until 1842, there were no duties in the British ports on coals exported to France or Belgium.				
In 1839, both those countries received English coals free of duty, either of export or import; and matters so continued till 1842.				
In 1845, duty on Belgian coals entering France,			2 6	0.60
In 1847, high rate of duties on imported coal.				
In 1815, the duty on the coal imported into France from Prussia, was only 0*fr.* 16*c.* per 100 kilog. =15*d.* per ton.				
In 1838, reduced to the nominal duty of 10*d.* sterling.				

* Courrier Francais.

Official statement of the quantity of foreign coal, in metrical quintals, arrived in France, and the amount of duties paid thereon into the national exchequer

Years.	Quantity received.		Duties received.	
	Metrical quintals 10,1465 to 1 ton.	English tons of 2240 lbs.	Francs.	£ sterling.
1844	16,354,695	1,611,930	3,737,505	161,100
1845	21,325,691	2,101,880	4,871,661	209,985
1846	20,561,168	2,026,520	4,903,589	211,360
1847	16,500,000	1,650,000		

IMPORTATION OF FOREIGN COAL INTO FRANCE.

The foreign coal trade of France, has necessarily, at all times been a fluctuating one; subject from time to time, to a number of influences, such as wars, tariffs, and commercial treaties. In a future statistical table we will exhibit the periodical supplies of coal furnished to France from foreign sources. These sources are, in fact, limited to three; namely, Prussia (Saarbrück,) Belgium, and Great Britain.

If we take as the basis of our calculation the supply furnished by Great Britain in 1815, a period of commercial tranquillity, and represent it by 1.0, the relative importations from that and the other countries will be expressed by the following figures, for the years 1815, 1845, and 1847.

	1815.	1845.	1847.
Importations from Great Britain,	1.0	25.0	61
" from Prussia,	1.3	10.0	61
" from Belgium,	9.0	62.0	45

The foregoing table exhibits, as we have stated, the relative supplies furnished by those countries, at three separate intervals, proportionately to the amount derived from Great Britain in 1815, represented by 100.

It will further illustrate the periodical progress made by each country if we assume as unity, or 1.0, the importation from each of them in 1815; and hence we shall show the comparative quantities derived from the same basins, at every ten years, subsequently. On this principle, they will be represented by the following figures, showing the advances made by each country.

Year.	Great Britain.	Prussia.	Belgium.
1815	1.0	1.0	1.0
1825	1.2	1.3	2.0
1835	4.3	3.1	3.0
1845	25.0	7.7	5.5
1847	61.0		5.0

Thus, while in thirty years, Great Britain increased her exportation to France twenty-five times, Prussia advanced 7.7 fold, and Belgium 5½ times. The intermediate advances of each country are shown in the same table.

The relative proportions furnished by each country in 1845, stand thus—Prussia 1, Great Britain 3, and Belgium 5.

We take special note of the following regulation as to the jurisprudence of the coal mines of France in 1845-6. "The combustibles employed in industrial establishments, for the preparation of products designed for general commerce, are exempt from the payment of the "droits d'octroi."*

From Rhenish Prussia and Rhenish Bavaria.—The coals which are imported into France under the generic denomination of Saarbrück coals, are obtained not only from the collieries situated in Rhenish Prussia, in the environs of that city, but also from those which occur not far from thence, in Rhenish Bavaria, in the district of Saint-Ymbert. These "exploitations" form part of a vast basin which extends even to the left bank of the Rhine, towards the embouchure of the Nahe. The quantity imported into France forms very nearly the half of the total production; the greater part of the other half is used on the spot in iron works, &c.—the rest is consumed in the valley of the Moselle, and in the region of the valley of the Rhine, comprised between Bonn and Mayence; and for the steamboats on that river.† For the most part the coal of Saarbrück has hitherto been brought by land transportation.

In 1837, the quantity of coal received in France by the navigation of the Moselle and the Bas-Rhin, amounted to 130,000 tons; in 1838, 123,645 tons; in 1839, 153,660 tons.

From Newcastle.—In the year 1848 the trade betwen Newcastle and France was performed by 1312 vessels, registering 170,346 tons, of which there were under the English flag, 1140 vessels, 151,678 tons; under the French flag, 172 vessels, 18,668 tons.‡

A correspondent of the Mining Journal, 8th November, 1845, says, that although France has abundance of coal, it is desirable to import from England some which is better suited for certain purposes than the French coal; and, more especially, the *small coal*, so useful for cooking, and employed in so many ways by the artisan. In England, this species is a mere drug; and if the French government should reduce or abolish the customs on this small coal, it would be really advantageous to both countries. The masses of small coal, accumulating in the north of England, may be imported into France, to the great advantage of the manufacturing and railway interests of that country; and the coal-fields of Northumberland and Durham would be delivered of an unprofitable mass; the shipping interest of both countries would be brought into profitable activity; and the French public would begin to have cheaper iron.

From Wales.—Welsh steam coal has greatly increased in demand in the French ports, as appears by the evidence before the committee on the coal trade (port of London). The French buyers are represented as extremely particular, and always stipulate that the coals shall be skreened in the port of delivery, and fix the size of the skreen to be employed.§

DETAILS OF THE IMPORTATION OF COALS, LIGNITE, AND ANTHRACITE INTO FRANCE.

In a previous table, we showed the periodical gross amounts, in metrical quintals, of foreign coal imported into France. We exhibit, in the follow-

* Annales des Mines, 1845, Vol. VI. p. 602.

† Comptes rendu des travaux des ingénieurs des mines pendant l'année 1839, 1840, 1841.

‡ Angleterre—Faits commerciaux—Mai et Juin, 1844.

§ Port of London Coal Trade Bill, 1838, p. 116.

ing table, the respective proportions which the coal producing countries, Great Britain, Belgium, and Rhenish Prussia [Saarbrucke,] contributed towards this annual gross importation. In this return, a discrepancy will be observed in the number of tons, as compared with many other published tables. For the sake of more rapid reduction of French metrical quintals into English tons, it is commonly the practice to consider ten quintals as making one ton. Our calculation has, however, been worked out in exact detail, after the correct rate of 10.146 metrical quintals to the English ton. The French custom-house returns always differ from the English, and may be explained by the fact that where no duties are payable on exports, as is the case with England, the entries are frequently made in excess by the merchants.

Annual Importations from

Years.	England. Tons. 10.146 qu.	Belgium. Tons. Engl.	Prussia and Rhenish Bavaria. Saarbruck.	Various small places. Tons.	Total imported. Engl. tons.
1787	155,260	49,300	9,860		214,420
1788	184,773				
1789	177,550	49,320	9,860		237,730
1802		86,830	17,750		114,400
1815	22,432	198,462	28,500		249,394
1820	24,800	224,100	27,500	774	277,174
1821	26,515	251,801	39,808	2,468	502,865
1822	31,105	267,777	35,625	2,741	538,880
1824	25,452	394,383	38,675	3,054	547,456
1825	26,684	439,248	37,221	3,774	630,920
1828	35,674	470,869	65,178	6,866	696,623
1830	50,360	503,750	74,340	14	628,464
1832	37,525	489,604	46,161	2,596	575,886
1834	48,267	611,610	76,960	24	736,861
1835	97,110	596,520	88,520	21	782,171
1836	167,170	706,170	112,310	184	985,834
1837	219,920	777,180	131,110	312	1,128,522
1838	300,470	785,440	123,440	750	1,210,100
1839	340,300	740,800	156,300	493	1,237,893
1840	394,954	748,750	160,779	507	1,304,990
1841	451,003	916,128	167,950	482	1,535,563
1842	515,975	902,710	169,610	815	1,590,110
1843	455,105	978,721	209,950	2,150	1,645,926
1844	421,539	1,096,057	209,660	3,360	1,611,930
1845	557,607	1,376,075	237,232	4,519	2,175,433
1846					2,026,520
1847	600,000	1,345,000	184,600	6,826	2,136,000 [first 11 months.]

The results established by the foregoing tables are as follows, in thirty-two years, to 1847, inclusive.

The English coals imported have increased 27 fold between 1815 and 1847.
The Belgian " " " about 5 " " " "
The Prussian " " " $9\frac{1}{2}$ " " " "
The general importation of foreign coals $8\frac{1}{2}$ " " " "

In the thirty years prior to 1846, the production of coal in France increased four and one-third fold; and the gross consumption advanced five fold.

Amount of coal, cinders and culm *exported* from England, Scotland and Ireland to ports of France; according to the *British* Parliamentary returns.*

Years.	Tons.	Years.	Tons.	Value in Francs.	Declared value in Great Britain.
1802	9,860	1836	205,140	833,000†	£ 32,174
1820	24,800	1837	272,130		
1825	39,180	1838	300,470		
1826	36,420	1839	340,300	4,089,000	157,937
1827	40,550	1840	394,954	4,873,000	188,215
1828	35,920	1841	451,003	5,557,000	214,638
1829	42,160	1842	515.975	6,369,000	246,002
1830	53,720	1843	458,594		
1831	36,000	1844	412,902		147,336
1832	41,015	1845	647,967		220,879
1833	45,000	1st 11 m'ths of 1847	542,000		
1834	56,920				
1835	91,730				

Imports of Coal.

Since 1815, more Belgian coals have annually been imported by France than by any other country.

In the year 1788, when the import duty on English coals was little more than one-half that levied on Belgian coals, the amount received from Great Britain was 184,773 tons.

In 1814, after many years of war and interruption to commerce, the position of these exporting countries was reversed, and the English coal paid four times the duty that the Belgian coal did, until 1834, when they were more nearly equalized. During these preceding twenty years, the average imports of English coal did not exceed 30,000 tons.

In 1834, the importation was 56,000 tons; after which the English export duties, and also nearly half the French import duties were repealed.

In 1840, after the French duty had been reduced to one-half, the amount was 394,000 tons.

In 1845, the importation from England had increased to 647,000 tons. The increase is attributable to the absence of export duty in England, and the small import imposed in France, in consequence of her want of coal.

Such are the fluctuations of trade when influenced by the policy or necessities of governments, in the imposition of tariffs, whether for exclusion, protection, or for revenue.

For several years past the navigation between Belgium and Paris has been greatly improved;—the use of coal from that country constantly extends more and more in France.‡

Increased demand for Foreign Mineral or Bituminous Combustibles in France.

It will be perceived, from the details of the preceding statistical table, that the increased amount of mineral fuel consumed in that country is

* British Parliamentary Records of Revenue and Customs.

† Faits Commerciaux—Commerce de la France avec la Grande-Bretagne, 1843.

‡ Bulletin de la Commission centrale de Statistiques, Bruxelles, 1843; Documents sur le Commerce exterieur, July, 1844, and Nov. and Dec. 1843; Dictionnaire du Commerce; Tableau Chronologique de la Production et de Consumption des Combustibles en France; Resumé, 1838, 1842.

rather ascribable to the importations, than to the augmentation of the indigenous supply. We take the period of the last twenty-five years, of which our tables afford the requisite details for comparison.

	1820. Tons.	1844. Tons.	Increase per cent.
Imported,	276,400	1,781,519	544
Indigenous production,	1,078,560	3,728,306	246
Balance of consumption deducting exportation,	1,328,870	5,458,054	310

Hence it appears, that while the general consumption has increased in the ratio of 310 per cent., between 1820 and 1844, inclusive, that of the indigenous production was 246 per cent. only; while the importation, during the same interval, was 544 per cent., or by including 1845, the increase was 665 per cent. It is inferred from these facts that, in order to keep pace with the manufacturing requirements of the country, France must continue to depend on an accelerated amount of imported coals, rather than upon her home resources, which thus appear to be inadequate to her actual wants by nearly 48 per cent. on the actual consumption.

By a return of the quantity of mineral and vegetable fuel which was received at the quays of Paris in 1844 and 1845, we are supplied with the following information.

	Hectolitres.	English Tons.	1845. Hectolitres.	English Tons.
Coals and Coke in 1844,	2,220,707 =	197,220	2,440 574 =	216,747
" " 1838,	1,567,359 =	139,197		
Charcoal 1840,	2,721,613 =	241,706	3,101,176 =	275,415

Both coal and wood are extremely expensive in Paris. The consumption of wood and charcoal in France, within the last ten years, has so much increased, that the royal forests present now but open wastes, and the coal production cannot keep pace with the demand. The steam vessels, forges and other requirements for coal and wood have so increased that large quantities of the former are imported from England and Belgium, and of the latter from Germany, Sweden, and the north of Europe.

In constructing similar tables of gross consumption, it is not unusual to add one sixth for the local consumption by steam engines, labourers, and residents. We have not so done in the present instance.

The original returns in the following columns were made as usual in French metrical kilogrammes. In all these cases, we have transferred them into the common denomination of English tons. We derive the details chiefly from the "Résumé des travaux statistiques de l'administration des mines;" the "Compte rendu des travaux des Ingenièurs des mines," and the "Documens sur le commerce exterieur." These details occasionally differ from each other; and, in like manner, the tables which we have constructed differ from those in common use, where for the sake of convenience the number of quintals to an English ton are assumed as 10 instead of 10.1465. The English parliamentary returns of exports to France vary also from the French account of imports from England, but to no very important extent.

The production of France is about one ninth that of Great Britain.

Table of the annual *production* and *consumption* of the mineral combustibles, [coal, lignite and anthracite] in France, and of the *importation* of foreign coal; reduced from French kilogrammes of 10.1465, and from 10.146 metrical quintals to each English ton, and derived from the official French returns.

Years.	Indigenous *Production* of France exclusive of Turf, in English tons of 2240 lbs. Bituminous Coal. Tons.	Lignite. Tons.	Anthracite. Tons.	Total of Indigenous Fuel. Tons.	Imported Coal. Tons.	Exported Coal. Tons.	Balance or Consumption of Fuel. Tons.
1787				212,910	214,420	28,200	399,130
1789				221,890	237,720	29,590	439,020
1802				832,480	114,400	24,670	922,210
1811				763,010	118,370	29,590	851,810
1814	665,618				165,346		
1815	840,375	23,300	5,735	869,410	245,650	18,240	1,096,820
1820	1,027,178	43,977	7,405	1,078,560	276,400	26,090	1,328,870
1825	1,388,174	59,242	23,374	1,470,790	499,320	5,530	1,964,580
1830	1,741,841	64,348	30,761	1,836,950	628,450	5,920	2,459,480
1832	1,818,325	69,177	38,398	1,925,900	571,790	22,170	2,475,520
1834	2,315,499	86,064	53,987	2,455,450	736,870	22,310	3,170,010
1835	2,312,700	101,500	57,600	2,471,800	782,150	21,000	3,232.950
1836	2,544,835			2,801,050	957,530	26,060	3,732,520
1837	2,773,760	97,540	68,280	2.939,580	1,128,210	33,090	4,034,700
1838	2,904,030	99,700	66,530	3,070,260	1,210,090	34,900	4,245,450
1839	2,771,855	97,900	82,010	2,951,765	1,201,207	32,379	4,120,592
1840	2,440,555	113,480	405,980	2,960,015	1,272,800	36,800	4,196,115
1841	2,476,333			3,410,200	1.619,160	49,360	4.980,000
1842				3,593,000	1,647.770	37,770	5,203,000
1843	2,941,536	131,760	566,150	3,639,446	1,637,776	59,886	5,217,336
1844	3,010,586	146,000	571,720	3,728,306	1,781,519	51,771	5,458,054
1845	3,418,817	152,900	569,900	4,141,617	2,175,433	65,260	6,251,790
1846		146,100	571,720		2,026,520		
1847	1st 11 mo.				2,082,000		6,500,000

Summary of the total *production, importation, exportation, and consumption* of combustible minerals in France, during the years 1838, 1843, and 1845, exclusive of turf, in English tons, reduced from metrical quintals of 10.146 to 1 ton. "Mouvement commercial des combustibles mineraux, produits et importés."* In 74 basins and 56 departments.

Classes of combustible.	Details of Production. 1838.	1843.	1845.	From what foreign countries.	Details of Importation. 1838.	1843.	1845.
	Tons.	Tons.	Tons.		Tons.	Tons.	Tons.
Bit'us coal,	2,904,030	2,941,536	3,418,817	G. Britain,	300,470	449,105	557,607
Anthracite,	66,530	566,150	569,900	Belgium,	785,440	978,721	1,376,075
Lignite,	99,700	131,760	152,900	Prus. Stat.,	123,440	209,950	237,232
				Small sour.	740		4,519
Home product.	3,070,260	3,639,446	4,141,617	Imported,	1,210,090	1,637,776	2,175,433
Imported,	1,210,090	1,637,776	2,175,433	Distribution.			
				In mines,	1,602,430		
Exported,	4,280,350	5,277,222	6,317,950	In manu's.	1,561,490		
	34,900	59,886	65,260	In Domestic uses,	1,081,530		
Consum'n,	4,245,450	5,217,336	6,251,750				
					4,245,450	5,217,336	6,251,750

* Compte rendu des Travaux des Ingenièurs des mines, pendant l'annee, 1839, 1844 and 1846. Resumé des Travaux statistiques en 1838 et 1843.

Duties levied on imported coal, in France,*	1843	£147,455
" " "	1844	151,822
" " "	1845	196,834

Table of quantity of Fuel consumed.

General statement of the amount of *indigenous production, importation, and consumption* of coal, anthracite, and lignite in France, in the following years, in metrical quintals of 10.1465 to 1 ton, English; showing the periodical increase.

Years.	Indigenous Production. Met. quintals.	Imported Coal, in metrical quintals.				Consumption after deducting exporta'n Met. Quintals.
		Belgium.	Prussia.	England.	All others.	
1787	2,150,000	500,000	100,000	1,553,734	.	4,035,919
1802	8,441,800	880,977	180,000	100,000		9,351,800
1811	7,736,941	950,000	250,000			8,936,941
1820	10,936,578	2,272,122	278,143	251,194	7,740	13,481,220
1830	18,626,653	5,108,065	753,419	511,289	140	24,939,448
1840	30,033,820	7,486,002	1,607,790	3,807,739	5,070	42,567,115
1841	31,599,890	9,295,034	1,697,070	4,299,499	4,820	49,612,133
1842	35,920,843	9,779,349	1,720,761	4,907,382	8,150	52,034,156
1843	36,925,400	9,918,606	2,130,144	4.556,662	21,500	52,935,082
1844	37,829,250	11,157,949	2,090,367	4,276,936	33,607	55,868,501
1845	42,020,919	13,961,604	2,406,954	5,657,489	45,842	64,092,868
1847 First 11 months.		16,950,290	1,846,365	6,000,000	6,826	65,000,000

Details of the balance of *consumption* of mineral fuel, in France, reduced from French metrical quintals to English tons.

Kinds of Fuel.	1837. Tons.	1838. Tons.	1839. Tons.	1840. Tons.	1843. Tons.	1844. Tons.	1845. Tons.
Bit'us coal,	3,866,350	4,079,220	3,940,682	3,676,655	4,519,426	4,740,334	5,694,050
Anthracite,	68,280	66,530	82,010	405,980	566,150	571,720	570,000
Lignite,	100,070	99,700	97,900	113,480	131,760	146,000	153,000
	4,034,700	4,245,450	4,120,592	4,196,115	5,217,336	5,458,054	6,317,050
Turf,	426,300	390,090	412,300	440,830	656,000	.	520,000

The exportation of coal from France is unimportant, although increasing in the south; being about 70,000 tons annually. A part of this is to Belgium, and to the countries upon its eastern borders, to the frontiers of Savoy, Switzerland, Spain, Sardinia, and the Grand Duchy of Baden, besides some to Algeria; but the greater part is from the basin of Alais to various ports along the Mediterranean sea.

Years.	Tons.	Value in Francs.	Years.	Tons.	Value in Francs.
1838	35,300		1843	59,880	600,000
1841	49,360	720,000	1844	51,770	520,000
1842	37,770	834,000	1845	66,000	

* Paris correspondent, Mining Journal, Jan. 31, 1846.

The following statements exhibit a summary of the progress or movements of the production, importation, and consumption of mineral fuel in France; prepared from the several tables already presented.

Movement of Indigenous Production,

Assuming the production of the year 1789 as 1. or unity.

Years.	Proportions.	Years.	Proportions.
1789	1.00	1837	12.42
1811	3.22	1842	16.24
1821	4.72	1845	17.10
1831	7.33		

Movement of Importation.

Proportionate importations of foreign coal into France from the three principal exporting countries; Great Britain being represented as 1.00.

	1815.	1825.	1835.	1845.
Great Britain,	1.0	1.2	4.3	25.0
Prussia,	1.3	1.6	4.0	10.0
Belgium,	9.0	19.6	26.6	50.0

Movement of Consumption.

Proportionate consumption of indigenous and foreign coals in France, during a period of fifty-six years; that of the year 1789 being represented as 1.00. The annual exportations are previously deducted from the aggregate of production and importation.

Years.	Proportions.	Years.	Proportions.
1789	1.00	1837	9.09
1811	1.92	1842	11.85
1821	3.07	1845	14.39
1831	5 11	1847	14.80

GENERAL STATEMENT OF THE EIGHTY-EIGHT COAL, ANTHRACITE AND LIGNITE BASINS OF FRANCE.

The following table exhibits the names and distinguishing characters of the eighty-eight coal, lignite and anthracite basins of France, in the respective provinces and departments.

This table is chiefly compiled from the "Compte Rendu des Travaux des Ingénieurs des Mines," periodically published by the French government. Some of the statistics are obtained from the "Traitè de l'Eclairage au gaz, par Pelouze pere," and various other authorities, among which are the "Bulletin de la Societé Géologique de France;" "Office de Publicité," of Paris; "Annales des Mines;" Resumé des Travaux Statistiques de l'Administration des Mines;" "Documens sur le Commerce Exterieur;" "Dictionnaire du Commerce;" "Journal des Mines."

The separate details of these basins are given in another part of this work.

Provinces.	Departments.	No.	Coal Basins.	Description.
Flanders,	Du Nord,	1	Valenciennes,	A prolongation of the great coal-field of Belgium. Contains 50 seams; the pits very deep. Both coking and dry coal, or anthracite. Valley of the Schelde. The Anzin mines furnish fuel for the iron works there, and for Paris.
			Douai,	Probably the western extension of the Mons and Valenciennes coal-field.
Artois,	Pas de Calais,	2	Hardinghen and Fiennes,	Five seams, yielding two sorts of coal: one of them coking, pure and proper for the forge; the other is strongly charged with pyrites.
Isle de France,	Oise,	3	Muyrancourt,	Lignite basin.
	Aisne,	4	Bourg,	" "
Lorraine,	Moselle,	5	Forbach,	Opposite Saarbrück, in Rhenish Prussia. Contains both coking and cementing coals, and also thin and mixed coal, used for forges. Mines deep: faulty.
	do		La Nied,	Lignite basin.
	Vasges,	6	Norroy,	Sometimes coking, but generally only half coking. Quality middling. Occurs with rognons of carbonate of iron.
Alsace,	Bas Rhin,	9	Basin de Villé,	Dry coal; sometimes schistose; five beds.
	do	8	Bouxwiller,	Lignite basin.
	do	7	Lobsann,	" "
	Haut Rhin,	10	Saint Hippolyte,	Coal of very good quality for iron works.
	do	11	Hury,	Detached coal patches.
Alsace,	Haute Saone,	12	Ronchamp and Champagney,	Coking coal: coke tumid but friable: used for forges and salt works. Two beds. The working commenced in 1750. Anthracite beds at Betschweiler, &c.
Franche Comte,	Haute Saone,	14	Gémonval,	Fat coals, with long flame, for forges, &c.
Franche Comte,	Haute Saone,	13	Gouhenans,	Resembles the coals in the Ronchamp basin.
	Doubs,	15	Le-grand St. Denis,	Lignite basin.
	Jura,	16	Grozon,	
Burgundy,	Côte-d'Or,	17	Sincey,	Anthracite basin in a primary region.
Nevernois,	Nièvre,	18	Decize,	Coal of two qualities. 1, coking; 2, a little dry, but burns with flame. Used in iron works. Four beds.
Burgundy,	Saone et Loire,	19	Épinac and Autun,	Area 62,500 acres, of which 20,510 acres are near Epinac. The coal is conveyed to the Burgundy canal, and thence through Alsace and the valleys of the Yonne and the Seine.
		20	Creusot,	Area 80,830 acres; pits 650 to 870 feet deep at Creusot. The coal seams are peculiar. They are not in strata, but rather in unequal masses, exceeding in thickness all others known.
			and Blanzy,	Contains four qualities of coal, varying from fat coal to anthracite. Probably connected with the coal basin of Bert. Small basins of Bourbince and Dheun.
		21	La Chapelle-sous-Dhun,	Four beds, two of which are worked.

Provinces.	Departments.	No.	Coal basins.	Description.
Berri,	Allier,	22	Bert,	Coal of various descriptions.
		23	Fins et Noyant,	Variable quality.
		24	Doget,	
		25	Commentry,	Coking coal; a little pyritous, but makes good coke. Four sub-basins.
		26	Buxiere-la-Grue,	
Auvergne,	Puy-de-Dôme,	27	Saint Eloy,	Dry, impure, and schistose.
		28	Bourg Lastic,	Two seams. Good coking coal at Singles. Dry coal at Messeix.
		29	Brassac,	Twenty-five to thirty coal beds. Those nearest the primitive rocks are dry coals, resembling anthracite. Those above these furnish a coking coal. See the tables of analysis.
		30	Puy St. Gulmier,	Anthracite.
Auvergne,	Cantal,	31	Haute Dordoyne, or Champagnac,	Several beds of fat blazing coal, occurring in lenticular masses. Coal of Mauriac, bordering the Dordoyne; good coal for furnaces of boilers, &c., inclosing much carbonate of iron.
		32	Mauriac.	Deposit of good coal.
Lyonnois,	Loire,	33	Basin of the Loire, St. Etienne,	The largest and most important in France; containing 103,040 acres of coal formations. That of St. Etienne comprises 51,642 acres. The basin of the Loire is divided into two groups. That of St. Etienne contains 18 coal beds of the best known fat coal, producing excellent coke.
		34	Bully,	Anthracitous formation.
		35	Roanne,	Anthracite basin.
Lyonnois,	Rhône,	36	Sainte Foy-l'Arguentière,	Coal rather dry; heavy; with much ashes. Three seams, near Lyons.
		37	Rive de Gier,	Ten or eleven coal beds, like those of St. Etienne.
Burgundy,	Ain,	38	Douvres,	Lignite basin.
Dauphiny,	Isère,	39	Voreppe,	Lacustrine lignite.
		40	La Tour-du-pin,	Lignite basin.
		41	La Tarontaise,	Anthracite.
		42	L'Oisans,	Anthracite basin.
		43	Le Drac,	" "
Languedoc,	Haute Loire,	44	Langeac,	Coking coal, of middling quality.
	Ardèche,	45	Aubenas,	Mouths of the Rhone. Coal dry and friable at Prades; coking and of good quality at Pigere.
Dauphiny,	do	46	Banc Rouge,	Lignite basin.
	Hautes Alpes,	47	Briançon,	Anthracite basin.
Provence,	Basses Alpes,	48	Manosque,	Lignite basin.
	Vaucluse,	49	Orange,	Coal classed with the lignites.
		50	Méthamis,	Lignite basin.
	Bonches-du-Rhone,	51	Aix,	" " Anthracite basin.
	Var,	52	Frejus,	Lignite basin.
	do	53	La Cardière	
	do	54	Toulon,	" "
	do	55	Vescagne,	
	Gard.	56	Le Vigan,	Good coking coal.
		57	Bagnols,	Classed with the lignites.
Languedoc,	Gard and Ardèche,	58	Alais,	Some beds yield coking coal; others a dry coal or anthracite. The produce of the mines is chiefly consumed in the iron works of the district.
	Hérault,	59	Saint Gervais,	Eleven to thirteen coal seams, of divers qualities. The first concession was granted in 1769.
		60	Ronjan,	Two or three coal beds of middling description.
		61	La Caunette,	Lignite basin.

Provinces.	Departments.	No.	Coal basins.	Description.
Languedoc, (*continued.*)	Aude,	62	Durban and Ségure,	Three beds worked; of variable quality.
	Pyrénées-Orientales,	63	Estaver,	
	Tarn,	64	Carmeaux,	Coking coal of good quality; superior but friable. Two beds. The working of this basin commenced in 1752.
		65	Labruguière,	
Gascony,	Hautes Pyrenees,	66	Bayneres	Bituminous coal.
	Basses Pyrenees,	67	Orthes,	Coal mine.
Guienne,	Aveyron,	68	D'Aubin or Decazeville,	Generally fat coal. There are 23 coal establishments in this department. The produce is for the most part used in manufactures.
		69	Rhodez,	Coal of a middling character.
		70	Milhau,	Of a very inferior description. Classed with the lignites.
	Lot,	71	Figeac,	Of very bad quality; slaty and pyritous.
	Les Landes,	72	Saint Lon,	Lignite basin.
	Dordogne,	73	Terasson,	Dry, schistose coal, but burns with a long flame.
Limosin,	Corrèze	74	Argentat,	Coal of a good kind, but often mixed with slate and clay.
		75	Meimac,	Coking coal of good quality, but a little pyritous.
Marche,	Creuse,	76	Bourganeuf,	Anthracite, or very dry coal.
		77	Ahun,	Proper for grates and forges; of good quality when selected.
Poitou,	Vendée,	78	Vouvant,	Seven coal beds in this basin; both coking and dry.
	Deux Sèvres,	79	Chantonnuy,	Five beds, of very feeble power. Two basins, disposed in the form of a boat.
Maine et Perche,	Maine-et-Loire,	80	Basse Loire,	Chiefly dry coals or anthracite in the department of Maine et Loire. Six beds.
Bretagne,	Loire Inferieure,	81	Languin,	Excellent coking coal for iron making.
Touraine,	Indré et Loire,	82		Coal beds not fully proved.
Maine et Perche,	Sarthe and Mayenne,	83	Le Maine,	Anthracite basin.
do	Mayenne,	84	St. Pierre-la-Cour,	Of moderately coking character, but earthy.
		85	Bazouge de Chêmere,	Anthracite.
Bretagne,	Finistèrre,	86	Quimper,	Pretty good quality.
Normandy,	Calvados,	87	Litry, Bocage,	Two beds; the first or lowest resting upon the wall, furnishes coking coal; the other yields only a dry earthy coal. Supplies fuel to Bayeux, Virè, and Caen; and is used on the spot for lime burning.
	Manche,	88	Le Plessis,	Two seams of anthracite or dry coal. The coal-fields of Litry and Le Plessis contain 40,393 acres.

There are yet several small coal basins and patches of lignite and anthracite which are not separately detailed in the foregoing table. As has been already stated, we are unable to ascertain the true area of coal formations in France. The statements which reach us only exhibit the aggregate of the concessions in each district, and these amounts, of course, are progressively increasing. A few years ago the sum of the coal and anthracite concessions was 692,000 acres. In 1845–6 it amounted to 1,135,550 acres, including lignite.

DETAILS OF THE EIGHTY-EIGHT COAL, ANTHRACITE AND LIGNITE BASINS OF FRANCE.

A knowledge of the deposits of her mineral combustibles is indispensable to the domestic and manufacturing interests of France. If, as a writer has lately said, the mineral be the primary base of the manufacture of iron, the fuel is of equally essential importance, in this branch of industry. Inquiries into the properties and local value of the combustibles are entered into on every side; new discoveries are continually presenting themselves, and each year enlarges the area of our mineral statistics. We proceed now to the consideration of those of France.

In a recent work, of high value in relation to these subjects, it is premised that the term *Basin* is employed to signify the coal formations, generally. It has also been customary of late, as we have already stated, to divide these coal formations into five groups, and also to adopt the classification now employed by the administration of mines, which recognizes five descriptions of coal.* The plan of the present work, as it does not enter into the minute details necessary to the official reports, requires only a partial adoption of these arrangements.

We would mention here, among other excellent illustrations of these matters, the admirable map which accompanies the report of the engineers of mines, for the year 1840, which shows, with perfect clearness, the local details of home production and those of the consumption of foreign imported coals. The areas of the provincial markets connected with individual coal-fields, and the areas of consumption of imported coal, as well as the sites of the coal basins themselves, are detailed with a perspicuity deserving of imitation.†

No. I. *Coal Basin of Valenciennes, Department du Nord.*

Supposed area about 70,000 hectares: comprising nineteen concessions, and 54,440 hectares, in 1845.

The coal mines here are considered to be not only the richest but the oldest in France, its area being a prolongation of the great coal formation of Belgium.

In 1719, researches for coal, which had been already known during several centuries in the vicinity of Liege, commenced in the territory of Anzin; and, in 1734, led to the discovery of that mineral, which shortly after became the centre of those operations which have since attained such great importance.‡ This was in the immediate vicinity of Valenciennes.§

In a treatise upon the application of geology to economic purposes, M. Burat adduced a remarkable instance, in the original trial for coal at Mons, at Valenciennes, and Douay, where, as above stated, mines were opened in 1734; at first unsuccessfully. The proprietors, in after years, followed the known direction of the axis of the basin, in which the coal was lying; and, although the cretaceous rocks covered up and hid the coal measures, yet as there appeared, from the structure and condition of the associated old rocks, that no great disturbance was to be feared, the search was persisted in; and, at length, was rewarded by the discovery of the mines of Anzin; after an

* Traité de la fabrication de la fonte et du fer, Paris, Dec. 1845.
† Compte Rendue des Travaux des Ingénieurs des Mines, pendant l'annèe 1839.
‡ Résumé des Travaux statistiques de l'administration des mines, en 1838, p. 15.
§ Dunn, on the Coal Trade, 1844, p. 192.

expense of about three millions of francs, equal to $580,500 = £120,000, had been incurred.*

The coal basin which extends from the banks of the Rhine, even as far as Arras, in passing by Liege, Namur, Charleroi, Mons, Valenciennes, and Douay, is covered, at several points, by an enormous thickness of barren formations, belonging to the cretaceous and tertiary periods, which the miners of the north of France have called "*morts-terrains*,"—dead lands. Into the details of these overlying rocks, however interesting of themselves, it is not our purpose to go.

In order to reach the coal beds, it is necessary to pass through these overlying barren masses; but as they are of an open and porous nature, it becomes absolutely necessary, on commencing to mine the coal, to complete a series of preparatory works of high importance, which can only be accomplished with certainty and safety through the medium of a practical enlightenment. It is, therefore, expedient to shut out of the shafts the waters of infiltration, as well as the waters which proceed from the first and second formations which are passed through by these shafts. This result can only be obtained by means of a complete *revêtement*, or impervious lining, within the walls or sides of the shafts. The mode in which this timbering and tubwork is effected, and the pumping machinery for exhausting the water, form the main purport of two memoirs by M. Turbert; one consisting of ninety-three pages, the other of fifty-three pages.†

These shafts, which are very expensive, and require much care in the workmanship or construction, vary in depth, from 220 to 800 feet, English, ere arriving at the commencement of the formation which contains the coal. The second memoir of M. Turbert refers to the operations which are pursued in the shafts, after having descended through the watery "dead formations."‡

A distinguishing feature of the coal basin of Valenciennes is the great number and thinness of the beds. In some parts, more than fifty seams have been recognized, whose thickness ranges from one-third to three-fourths of a metre, and the maximum is only one metre or 3¼ feet. At Fresnes, and at Vieux-Condé, forty beds are worked, which have a total thickness of 34¾ English feet. At Anzin, eighteen seams comprising 46½ feet; at Aniche, twelve seams containing 23½ feet: and at Denain, four beds having only 9¼ feet, altogether.

In this northern coal basin, we are informed, the art of ventilation and the general method of working deep mines, was first studied in France. It was a fine field for the accomplishment of the more difficult operations of the art; for the coal strata occur singularly disturbed, in a zig-zag direction, like a combination of a number of the letter z.§

The mines of this basin employed, in 1838, above 9000 work people. There are now nineteen establishments or mines, the concession of 1842, covering an area of 69,025 hectares, or 170,560 English acres. Seven of these mines belong to the company of Anzin. Fifty-two shafts are established there. They descend, in the middle of the basin, as low as 475 metres, equal to 1558 feet, and at Anzin, in the great vein, to 503 metres or 1635 English feet, being the deepest mines in France. The whole of the field in

* Géologie appliquée, par M. A. Burat, Paris.

† Sur la travassée des morts-terrains dans le nord de la France. Annales des Mines, Vol. III. p. 73 to 166, 1843.

‡ Sur la percement des puits des mines dans le nord de la France, apres la traversèe des niveaux, p. 293 to 346, 1843.

§ Explication de la carte géologique, par Elie de Beaumont.

1842, had eighty-six shafts, worked by eighty-three steam engines, of the force of 2247 horses. The amount of coal raised that year was 850,000 tons; which, at the price of 16*s.* 8*d.* per ton, produced £711,875. The cost of its production was estimated at 0 fr. 65 c. per hectolitre,=7.32 fr. the ton, = 5*s.* 10*d.* Engl. = $1.41 U. S. per ton.

Mr. Dunn was informed that in this district, where some of the coal pits are 620 metres in depth, the workmen are not allowed any other means of ascending and descending, than by ladders, some of which are perpendicular.

Of all the French departments, that of the north consumes the greatest amount of mineral fuel, with the exception of the Department of Loire; but it is favourably situated for receiving the Belgian coals, from that part of the great coal basin which extends to Mons and Charleroi. The neighbourhood of these mines is celebrated for the magnificent iron manufactories, of almost every description.*

Notwithstanding a large amount of indigenous coal is annually raised here, it is inadequate to the demand. Thus in 1837, when the production was 730,015 tons, the entire consumption of the department, including the indigenous and the imported, was no less than 1,440,000 tons, or nearly double the home supply, but circumstances have changed this state of things. The following statement shows the annual coal production of the mines of Valenciennes calculated in English tons.

Years.	Tons of 10.146 m. qu.	Years.	Tons of 10.146 m. qu.
1835	531,605	1842	907,160
1837	730,015	1844	927,000
1839	846,830	1845	930,000

Mean price at the pit's mouth in 1845, 10*s.*=$2.28 per ton.

Anthracite occurs in this basin in several of the mines. It has been the subject of a recent series of experiments, by M. Blavier, with relation to its employment in the grates or fire-places of steam-engines. These dry and meagre coals belong to the inferior beds of the system.† In 1845 there were 355,000 tons returned under the head of anthracite, and 575,000 tons under the head of fat coal with long flame.

Coal Mines and Iron-works of Anzin, in the Valenciennes Coal-field.

The property of this company comprises seven concessions, which amount to 26,564 hectares, or 65,329 English acres. The coal company of Anzin cleared annually nearly 3,000,000 francs profit, in consequence of the increased production and price of coal, prior to the alteration of the tariff in 1842.‡ These miners and those of the Loire, now furnish the city of Paris, in great measure. Besides supplying the immense iron-works, the produce of this coal-field is distributed by the Schelde, the Scarpe, the Oise, the canal of St. Quentin, and the Seine.

"It is really astonishing," writes a correspondent of the Mining Journal, "to see the colossal works of the coal company of Anzin. There are not only subterraneous, but exterior works for the supply of coal. Extensive forges, and workshops for constructing every description of machinery, have been erected:—rope-yards; an iron railway to unite the two establishments

* Traité de la fabrication de la fonte et du Fer. MM. Flachat, Barrault, and Getiet.
† Annales des Mines, 1843, Vol. IV. p. 497.
‡ Hugo. France Pittoresque; Art. Nord.

of Anzin and Denain; large ware-houses and timber-yard, for the use of these immense concerns. Denain, twelve years ago, was nothing but a small hamlet; at present it is a large town, with upwards of 6000 inhabitants: all the result of the discovery of a coal stratum. High furnaces, forges, and coke-ovens, have been built; and it will become a place of great mining industry in a few years hence."*

Du Nord.—Douai.—We have seen notices of the discovery of an extensive coal-field in the vicinity of the city of Douai. From the position which it occupies, in the same range as the coal districts of Mons and Valenciennes, there seems little doubt but this is but the western continuation of those great northern coal-fields.

The disposition of the common ventilating hearths in France and Belgium, consists in separating the lined or timbered portion of a shaft by a strong partition, which reserves on one side, for the service of the mine, a large section or principal shaft, and on the other a smaller section, which serves for the descent of the miners.

After having traversed all the height of the "*terrain mort*," and being arrived at the coal formation, that is to say, at the base of the lining, "*cuvelage*," the *goyau*, or miners' shaft, separates from the pit and descends, by ten yards and ten yards, by a series of little shafts called *beurtias*, isolated from each other by short galleries,—"*paliers*." It is by these *beurtias* that that the miners arrive at the lower portions of the works.

The fire for ventilation, *foyer d'appel*, is situated in a gallery especially placed in communication with the beurtias, for the entrance of the air which is destined for combustion, and the burnt gases are only conducted into the main shaft by an inclined gallery, of fifteen to twenty yards in length. Two solid doors, closing tightly, isolate the beurtias from the way of return; they are placed in such a manner that, at the time of the passage of the workmen, there is always one door closed. In consequence of this arrangement, the air which feeds the fire always descends from the exterior and is not thrown into the ventilation shaft until after a passage sufficiently long to avoid any danger of the ignition of the inflammable gas which is drawn thither by the upper current, *courant d'appel.*

II. *Coal basin of Hardinghen and Fiennes, Department of Pas-de-Calais.*

This basin occurs within the denudation of the Bas-Boulonnais, at the foot of an environing zone of chalk hills, and where the coal is worked, in several places, within the general limits of the overlying chalk formation.†

In the Bulletin de la Société Géologique de France, 1839, is a short geological notice and a map of this coal-field, the mines of which were under the management of M. Brongniart. The coal formation rests upon the carboniferous limestone, and that upon the regular series of the silurian rocks. There are evident analogies between certain parts of this basin and that of Belgium, and Valenciennes. Mr. Murchison regarded the coal measures of the Boulonnais, as being enclosed between two beds of carboniferous or mountain limestone.‡

This basin is far from extensive. It comprehends three concessions only; those of Hardinghen, Fergues, and Fiennes, whose area comprises 5226

* Mining Journal of London, 27th Sept. 1845.
† Coneybeare and Phillips's Geology of England, p. 467.
‡ Bulletin de la Société Geologique de France, tome X., p. 402—415, 1839.

hectares, or 12,600 English acres. It was discovered in 1730; immediately after which, operations were commenced for the extraction of the combustible, which operations, on a small scale, have continued, without interruption, to the present day.*

Here are five coal seams. The works are carried down to 221 feet in depth, and furnish two kinds of coal:—the one fat, with long flame; the other meagre, with long flame. The first is of a coking quality, proper enough for the forge; the second is strongly charged with pyrites, and is chiefly employed in the burning of lime.

Wood and turf are the principal species of domestic fuel used in the department. The coal which is consumed in the country is chiefly brought from Belgium.†

Annual production of bituminous coal here:

Years.	English tons.	Years.	English tons.
1835	3,730	1842	17,870
1838	5,170	1845	20,000
1841	19,180		

III. *Oise.—Lignite basin of Muyrancourt.*

This small basin supplies the neighbourhood, for the manufactories of alum and sulphate of iron.

IV. *Lignite Basin of Bourg, in the Department of Aisne.*—738 tons, only, raised in 1841, and 680 tons in 1845.

V. *Coal and Lignite Basins of Forbach; Department of Moselle.*

This little basin is, probably, a continuation of the great coal-field of Saarbrück, in Rhenish Prussia. In 1835, it yielded 3015 tons of coal, both of the coking and the mixed qualities; of late, it has been considered unproductive. At Schœnecken, in the basin of Forbach, on the extreme French frontier, several little beds of coal have been discovered, and it is reported that there is one seam of thirteen feet.

Amount of lignite raised in 1845 not returned.

Moselle—Lignite basin of La Neid.—The concession comprises 307 hectares. Production in 1845, 185 tons only.

VI. *Vosges.—Basin of Norroy.*

Gypseous coal of the red marl, England—Reuper Gern—Marnes Irisées, France.—This formation incloses, according to M. Drouot, a bed of coal, which has been traced over a considerable area, but has not, every where, a sufficient thickness to enable it to be worked. Its capacity never exceeds two feet.

It is by no means a pure coal; containing, besides argil and pyrites, fifteen per cent. of gypsum. This gypsum is fibrous, forming a multitude of small veins, ramifying in all directions. Sometimes the pyrites in the coal amount to seven per cent., and have to be separated by hand. The ashes of this coal contained seventeen per cent. of sulphate of lime.

Its calorific power, compared with that of a good coal of the Loire, taken

* Résumé des Travaux Statistiques de l'administration des Mines en 1838, p. 15.
† McCulloch, Universal Gazetteer, Vol. II.

as unity, is 0.780. Owing to the presence of pyrites it would be improper to use the coke for metallurgic purposes.*

"This basin consists of five concessions and 11,057 hectares of land. The coal is classed with the meagre coals with long flame, of which 1,400 tons were mined in 1845.

The Vosges Mountains, on the eastern side of France, are composed of granite and transition rocks, and at their feet are several coal-fields, covered by the newer red sandstone and the lias limestone, *muschelkalk*.†

The red or variegated sandstone of the Vosges, contains many vegetables, which have been identified by M. A. Brongniart; but they do not occur in sufficient abundance, at any one spot, to constitute a regular coal bed.

The Basin of Norroy yielded, in 1835, 1,350 tons. In 1841, 1,680 do. In 1845, 1,390 do.

The carboniferous beds are enclosed in the "*Marnes Irisées*" of the red sandstone secondary group. The basin consists of five concessions, whose area is 11,057 hectares, = 25,203 English acres.

A single bed is presented here, of 3¼ feet thick, the coal of which is very impure and pyritous.

IX. *Bas Rhin—Basin de Villé.*

Like the other isolated patches [Lambeaux] in this department of the Vosges, it rests upon transition schistes, and is partly covered by the *grès rouge*. There is only one concession, that of Lalage, whose area is 1,149 hectares, and only one thin bed of coal, worked on account of the extreme scarcity of fuel in this country. Yield, in 1835, 177 tons. In 1838, 195 do. In 1845, 168 do.

VIII. *Bas Rhin—Bouxwiller—Lignite Basin.*

This pyritous lignite is employed in the manufacture of alum and sulphate of iron, and is also used as a combustible for the same works, and in that of several other chemical products. Five-sixths of the lignite of Bouxwiller are thus employed at the place of extraction; the surplus is consumed at La Reidt, about two miles from the mine. Production in 1845, 7,900 tons.

VII. *Bas Rhin—Lignite Basin of Lobsann.*

This combustible is entirely consumed at the place of production, in the fabrication of bitumen and bituminous mastic. Yield, in 1845, 620 tons. Area, 1176 hectares.

X. *Haut Rhin—Saint Hippolyte.*

Reposes on a sandstone which passes insensibly into granite, and is covered by the *grès rouge* and the *grès de Vosges*. Two concessions and 2600 hectares. Yield, in 1835, 1000 tons. In 1838, 470 do. Price, 4 francs, 38 cents per metrical quintal. In 1841, 530 tons. In 1845, 270 do. Price, 20*s.*=$4.84 per ton at the mine.

This basin, situated on the western slope of the Vosges, contains two concessions, extending over a surface of 2600 hectares. The only bed worked is a few inches thick. It is disturbed by folds, and traversed by numerous faults. In quality, the coal is fat, with long flame.

* Annales des Mines, Vol. I., 1842, p. 683. Laboratoire de Chimie de Vesoul.
† Bakewell's Geology, p. 246.—Calcaire à Gryphites.

XI. *Detached Coal Deposits of the Haut-Rhin.*

There exist in this country a great number of isolated patches of the coal formations, which are scarcely important enough to be separately considered. That of *Hury*, however, is covered by a concession of 145 hectares. The seam is only eight inches, and faulty—the coal is dry, very solid, and affords much heat.

XII. *Haute Saône—Ronchamp and Champagney.*

The richest coal-field in the Vosges. It contains two seams whose united thickness is from six to ten feet. The highest of these is of middling quality; the lowest is a fat coal of good quality, but is now almost exhausted. Two concessions, comprising 3,790 hectares. Produced in 1835, 530 tons. In 1838, 9,010; price 2 franks per metrical quintal. In 1845, 15,000 tons.

XIII. *Haute Saône—Basin of Gouhenans.*

Three concessions, having a surface of 3,438 hectares. Produced in 1838, 2,350 tons. The coal resembles that of Ronchamp. These four coal areas yielded in 1835, 16,120 tons. In 1838, 18,110 do. In 1841, 17,320 do. In 1845, 91,000 do.

XIV. *Haute Saône—Basin of Gémonval.*

Embraces three concessions and 3,961 hectares. This carboniferous formation belongs to the "*marnes irisées*," old red sandstone group. The thickness of the seams does not exceed two feet. The coke is metalloid, spongy, and porous. Produced in 1838, 6,750 tons. In 1845, 2,000.

In the concession of *Corcelles*, the coal is of inferior quality, requiring to be purified by washing.

XV. *Doubs—Lignite Basin of Le Grand Saint Denis.*—Production in 1845, 680 tons. A single concession of 405 hectares.

XVI. *Jura—Basin of Grozon.*—One concession of 1100 hectares. No return of quantity.

XVII. *Department of Côte d'Or.*

The Coal-field of Sincey is situated near Avallon and Semur; confined within rocks of gneiss and granite. It forms a band extending almost in a right line, from east to west, a length of twenty-four kilometres, = fifteen English miles; with a variable breadth of from one hundred and nine to three hundred and twenty-eight yards. In all this extent it discovers itself, as well upon the plateau as in the lower flats. It has been hitherto supposed to be continuous; but a more complete study of its constitution and of its relations with the primordial rocks will probably show that it is formed of distinct portions, each completely isolated, in the midst of these rocks.

Be this as it may, this formation is limited on the north and south by granite and gneiss, which, in its vicinity, are traversed by veins and transversal masses of eurites, penetrating it at some points. To the east it is arrested by the lias formations, beneath which it is probably prolonged; for coal sandstone is found further in that direction. Westward, it appears in a thin band, traversing entirely the granite and gneiss formations in the

environs of Avallon: thus stretching from the secondary regions on the extreme east to those on its western flank; in the same manner as we see that the coal-field of Blanzy traverses the primary formations; separating completely those of the Autunois from those of the Chalorais.

The Sincey coal measures comprise conglomerates of fragments of granite and porphyry; crystalline feldspathic sandstones; and argillaceous schists with contorted laminæ, having a brilliant aspect, and numerous impressions of vegetables similar to those of the coal-field of Autun. These argillaceous beds, much contorted or disturbed, resemble those of the environs of Toulon, in the basin of Blanzy; and contain beds of dry coal which present all the characters of anthracite. The whole group of rocks has been forcibly upheaved and broken by a movement of the ancient rocks upon which it reposes; and presents, generally, the double dip to the south and to the north. The coal of Sincey divides itself, at the slightest blow, into lenticular pieces with glossy surfaces; attesting a trituration which was anciently exercised upon the entire mass by the walls of the formation; while the general character of the coal beds, forming long almonds, interlaced with schist or shale, confirms this hypothesis.*

At La Charmée, this combustible is stratified with beds of schist and sandstones, apparently of the true coal measures. The anthracite region of Sincey has, since 1835, been the theatre of the exploratory works of two rival companies. Several seams have been discovered; but one only, the principal bed, which has a mean thickness of a metre [3 ft. 28] is the seat of operations, [*travaux d'exploitation*]. The general character of this bed accords with the irregular, twisted structure of the individual blocks of anthracite extracted from the mine. It consists of a succession of lenticular masses, interlaced with schists, whose faces of contact present numerous striæ, produced by a slipping or sliding motion—*stries de glissement*. Hence, it appears that at the epoch of the uplifting of these beds, the whole mass of combustible was subjected to a trituration exerted upon the walls of the formation.

The Sincey anthracite is at present only employed, within a limited district, as a domestic fuel, and for burning bricks and lime. As its nature adapts it for the purposes of iron manufactures, it will no doubt eventually be more in demand.†

Production of anthracite in 1837, 800 tons. In 1841, 258 do. In 1845, none—the two mines are not now worked.

XVIII. *Department of Nièvre—Basin of Decize, in the Valley of the Loire.*

This basin was commenced to be worked in 1750, by virtue of a privilege granted by the Duc de Nivernais, upon payment of a ground rent or royalty of about seven centimes per one hundred kilogrammes.‡ This is equivalent to about three farthings sterling, or $1\frac{1}{3}$ cent of United States currency, per ton.

The geological position is interesting; the basin being overlaid, on three sides, by the tertiary formations of the valley of the Loire; and on the fourth, by those of the lias period.§

* Notice sur les bassins houillers de Saône-et-Loire, per M. Manès, 1843.

† Experiments made in the laboratory of Dijon, in 1841, by M. G. de Nerville. Annales des Mines, Vol. I. p. 541.

‡ Résumé des travaux Statistiques, &c. en 1838.

§ Annales des Mines, Vol. IV. 1843. M. Manès' Memoire.

Production in 1835, 30,160 tons. In 1838, 34,360 do. In 1841, 42,880 do. In 1846, 54,500 do.

It consists of a single concession of twenty thousand acres, granted in 1806. Its position is of great local importance, but the coal is, unfortunately, dry and anthracitous; by no means adapted for the smith's forge nor for coke. This area is concealed on all sides by beds of the *gres bigarré* or lias.

M. Burdin, some years since, estimated the total quantity of coal in this basin, at 90,582,916 hectalitres; which is equivalent to an annual production of 600,000 hectolitres during one hundred and fifty years. Contains seven coal beds, of which three are chiefly worked—1st, of ordinary quality, two yards thick; 2d, less pure, one yard and a half; 3d, best coal, two and a half yards. Coal of Decize.

Their united thickness is forty feet. The depth of the coal-pits is 260 metres,=845 English feet.

In general, the Decize coal is meagre, with a long flame; used for puddling, for heating boilers of steam engines, &c.

Production in 1842, 40,690 tons. In 1844, 42,900 do. In 1845, 54,000 do. The shafts have a mean depth of 250 metres, or 820 English feet. Mean price at the pit's mouth in 1845, 10*s*.=$2.40 per ton.

XIX. *Department of Saône-et-Loire—Basin of Autun and Epinac.*

Situated between porphyritic mountains on the west and north, and the granitic range on the south, this coal-field extends in length about twenty miles, and its maximum breadth is nine miles. The elevation of the first chains of mountains which surround them being from 400 to 500 metres above the sea, this area constitutes, at their feet, inferior hills which do not exceed 350 metres,=1150 feet, English. The deeper parts of this basin are covered by alluvial and tertiary deposits; while the small hills of Moloy and Curgy are crowned by secondary deposits in horizontal beds.

This coal basin is composed of two groups of rocks, reposing conformably upon each other. The inferior stage comprises the usual alternations of sandstones, psammites, puddingstones, and argillaceous schists, with coal beds and bituminous shales; without traces of fishes. This series is 290 metres,=950 feet thick.

The superior division, occupying the centre of the basin, four hundred feet thick, consists of alternate beds of slates, psammites—rarely of puddingstone—and thin subordinate beds of inferior coal. It is characterized by bituminous schists impressed with fishes; Palœniscus angustus and Pal. Blainvilli. Like that of Blanzy, the coal-field of Autun appears to be a local deposit.

The eurites and traps, which penetrate the rocks of the lower stage, announce a primary epoch of uplifting, contemporaneous with the coal formation. The arkoses and marles, covering the summits of the Moloy mountains, show that a second *soulèvement* had taken place after the deposit of the keuper. Finally, the horizontal deposit of tertiary clay, which covers the plateau of Curgy, proves that a third uplifting occurred after the formation of these clays.

The coal-field of *Autun*, circumscribed on all sides, will scarcely be enlarged by means of researches beyond its present known boundary.*

* Notice sur les bassins houillers de Saône-et-Loire, par M. Manès. Annales des Mines, Vol. IV. p. 463.

It contains a superficial area of about 252 square kilometres, [97½ English square miles,=62,500 English acres.]

That portion of it which is in the vicinity of Epinac contains 20,510 acres. The coal beds of *Epinac* were the first known, and for a long while the only ones explored. They were discovered in 1744, and were put in work in 1751.*

At Resille were established the first works, upon the thin seams which cropped out, and were followed with little activity until 1824. Two years after were discovered the thick beds of Fontaine, Bonnard, and Curier, and this discovery soon awakened the attention of the industrious. Then they commenced researches in numberless points, by borings or by shafts, along the margin of the basin, and even in its centre. These led to the establishment of the five concessions of Epinac, Moloy, Sully, Chambois, and Pauvray; comprising more than 83 square kilometres.

The four first named concessions, according to M. Manès' table in 1843, are described as follows:—Area of the four concessions, 27.8 square miles, =17,800 English acres. Thickness of coal beds, ten to thirty feet, increasing in power and regularity, in proportion as the works descend in depth. Number of worked beds at each position, two; of workmen employed, 570. There are three seams which have an aggregate thickness of 52½ feet. Annual quantity of coal extracted: in 1838, 69,100 English tons. In 1841, 75,500 do. In 1844, 83,000 do. In 1845, 86,500 do.

The basin of *Autun* and Epinac contains coal of every nature; from the anthracitous coals of La Vesure, to the fat coals, with long flame, of Saint Blaise. Those generally worked are of the medium quality, having a schistose fracture, affording from 65 to 70 per cent. of carbon; and the volatile matter, from 33 to 37 per cent. Among these, the coal of Sully is the most caking, and the most proper for smith's work; whilst for evaporating purposes, the coal of the lowest seam at Epinac is superior to all the others.

At present, it is only the concession of Epinac that is favoured with the facilities of transportation. This mine, after supplying the neighbourhood, disposes of the rest of the products by means of the railroad of 27,700 metres=16 miles, to the canal of Burgundy. The principal markets for the coal of Epinac are those of Paris, of Alsace, and Burgundy. The latter is the most important and profitable, and that on which these mines must place their chief reliance; and even there the demand is limited, on account of the employment of the superior coals of the Loire. This state of things renders it, of course, very desirable to create in the environs of Epinac some metallurgic manufactory or other, which will increase the local consumption.† Much of this coal is already consumed at the glass-works at Epinac.‡

A railroad connecting this coal-field with the canal of Bourgoyne, furnishes one portion of its products to Alsace, and the other to the basin of the Seine.

XX. *Saône et Loire, Basin of Creusot and Blanzy.*

The entire coal-field thus designated, extends about thirty-four miles in length, by nine and a half miles in breadth. The different mining establishments are opened along the circumference or edge of the basin; a dis-

* Commenced in 1763—" Resumé des travaux, en 1838," p. 15.

† Annales des Mines, Vol. IV. p. 485.

‡ Résumé des travaux, &c., in 1838, p. 15.

position which shows that they are placed on the outcrops of the coal beds. It is traversed in nearly its whole length by the central canal.

In 1782 was established at Creusot the first enterprise undertaken in France for the purpose of fabricating and elaborating iron by means of coal.*

This region is ordinarily subdivided into two coal areas, that of Blanzy and that of Creusot.

The coal-field of Blanzy occupies the little valleys of the Bourbince and the Dheune. It forms an elongated band, 25 miles in length, and 5,000 feet in breadth; passing in a north-east and south-west direction, and resting upon grauwacke and gneiss. The coal formation comprises the ordinary conglomerates, grits and psammites, argillaceous shales, and coal. It is the southern zone or border of the entire basin, overlying the gneiss. It exhibits conglomerates of fragments of gneiss and the common argillaceous slates, on whose laminæ are presented innumerable vegetable impressions; bituminous shales with scales and other remains of fishes; finally, coal seams which are commonly dry and earthy.

These coal seams are disposed sometimes in thin beds, which are separated from each other by from 75 to 190 feet of rock, and perfectly stratified; and, at other times, in thick beds which appear to result from the re-union of the first, by the diminished thickness of the intermediate sandstones; and taking, at some points, the appearance of true masses or aggregations. All these have been disturbed by many accidents and irregularities, and are traversed by numerous faults.

The northern zone or margin, which overlies the silurian series, and is most developed at Creusot, and comprises conglomerates of fragments of porphyry and quartz; argillaceous schists in thick masses, in which few impressions are found, but disseminated rognons of coal and carbonate of iron; finally, fat coals more or less earthy, occurring in beds which are seldom of importance, but disposed like strings of beads [*en chapelet*].

The locality of Creusot is the only one in this northern zone which contains a great richness in coal. It appears, otherwise, to have been much disturbed in its western part, where great undulations may be observed, and where the coals vary in their nature from the most fat even to the most dry.

The new red sandstone [*grès bigarré*] which occupies the interval, six miles wide, between these two bands or coal areas, is composed of conglomerates, variegated sandstones, and red shales. In a few positions this series is surmounted by *keuper* and lias rocks.

M. Manès considers this as the only coal-field, within the district of Morvand, where explorations, undertaken beyond the present apparent limits, will be attended with much chance of success. The sections show, almost to a certainty, that this is really one continuous coal basin whose interior is filled up or concealed by later formations. If, as seems very probable, this coal basin continues beneath the tertiary formations on each side of the valley of the Loire, to connect with the coal-field of Bert, the aggregate area of coal will be considerably greater than that we have now assigned to it.

The existence of coal has been known from time immemorial in this basin. The registers of Plessis in 1528, of Ocle in the same year, of Montcenis in 1610, of Torcy in 1640, establish the rights of the lords over the coal lands. These rights exacted the third, and sometimes the two-thirds, of the coal extracted.

The first works that were established appear about the date of 1769, when

* Résumé des travaux, &c., in 1838, p. 15.

the lord mortgagee [*engagiste*] of the barony of Montcenis obtained the exclusive right, during fifty years, to mine the coal of this barony, over an extent of thirty-one square leagues. These works, however, did not arrive at any importance until after the establishment, in 1782, for the service of the navy, of the foundry and high furnaces of Creusot, in the same barony. In that year a new mine was opened, that of Saint Berain; which concession was granted over an area of twenty-one square leagues, for twenty-five years. It supplied, exclusively, the glass-works which were established in this commune.

These two concessions were confirmed by the law of 1791, which, however, limited them to six square leagues each; and, still later, the evil consequences of such enormous grants becoming daily more apparent, they were subdivided, and new concessions were introduced. There are still extensive areas of coal lands remaining free.

The following statement indicates the importance of the fifteen concessions occupying, in 1846, the principal part of the coal basin of Blanzy:

Total area of the fifteen concessions,—327.3 square kilometres, or 32.732 hectares,=126.3 square miles,=80,830 acres. Of these fifteen concessions six are in regular operation, six are in a state of exploration or of irregular working, and three not yet worked in 1843.

The number of coal beds worked in each of the six concessions, are three. Thickness of each bed, from four feet to forty-nine feet. Here is worked by means of pits 200 metres, or 656 feet deep, a mass of coal, very nearly vertical, whose thickness is sometimes 24 metres, [79 feet,] and occasionally 45 metres, or 148 feet. The number of workmen employed, is 2,143 persons.

Annual production of coal from the basin of Creusot and Blanzy:

Years.	Tons of 10.146 m. qu.	Years.	Tons of 10.146 m. qu.
1835,	130,000	1844,	225,000
1842,	233,000	1845,	300,000

The coal basin of Blanzy contains the four following species:

1. Anthracitous coals,	Produces of pulverulent coke, 85 to 90 per cent. do. volatile matters, 15 to 10 do. At present only employed in the heating of boilers.
2. Fat coals, two varieties.	Yields a tumid coke, about 70 per cent. of ashes, from 5 to 10, and to 25 per cent. volatile matters, 20 to 25, and to 36 per cent. Employed in the generality of industrial purposes.
3. Medium fat coals,	Coke, porous and friable, 60 to 70 per cent. Volatile matters, 35 to 45 do. Used for boilers and furnaces.
4. Dry coals, burning with a long flame	Coke, - - - - - 50 to 60 per cent. Volatile matters, - - 40 to 45 do. Used for furnaces and for domestic fires.

The Blanzy coals are conveyed from the mines to the canal of the Centre on small railroads, of 1000 to 1500 metres each: those of Creusot to the same canal, by a railroad 10,356 metres, [nearly seven and a half miles.] This canal conducts part of the coal to the Loire, part to the Saône, and the remainder by the canal of the Rhone, to the Rhine.*

* Annales des Mines, 1843, Vol. IV. p. 463.

Blanzy, Methods of Working.—This bed, which is about forty feet thick,* has been minutely described by MM. Chagot and Harmet.

The working or exploitation of this bed is carried on as follows:—It is at first commenced upon the upper course, by *massifs courts*, the cuttings having four yards of breadth by two and a half yards in height, and the pillars having thirty-six to forty feet in breadth, and one hundred feet in length in the inclination of the seam. After this first division, which is, to a certain extent, only a preparatory work, they attack at once the pillars and the portion [*rabattage*] of two yards left at the head of the galleries. This main seam is then worked by three stages or courses, the lower one being carried forward the first; the second, which is supported by timber on removal of the first portion, succeeds, and the third, upon the same principle, is detached from the first seam of slate, in the roof, by miners who are mounted on wooden trestles; and thus proceeds the excavation of the column of coal apportioned for this section of the seam. The roof of this excavation sustains itself sufficiently for the usual distance of four yards of undermining; after which they expect its fall, which occurs in two or three days. The slower it is in falling, the more necessary to redouble the precautions of the workmen; because it gives way all at once. When the miners are at work, the ear is, for them, the best guide; they hear, very distinctly, the rocks cracking before the fall; and it is very rare that a crushing down, *ecrasement*, takes place without sufficient warning. We have not attempted to follow the details furnished by the authors last quoted, because they so abound in technical phraseology as to be almost untranslatable.

The excavation of the first stage being terminated, it remains yet to work the larger and lower moiety of the bed, in which they proceed as follows:—After having left the rubbish of the upper stage to settle down during about two years, the preparatory works are opened, in the inferior stage, upon the wall of the bed.

The cases of falling down or crushing, are much less dangerous in this stage than in the upper stage, because they are more under control. The roof or upper stratum, which falls only in lengths of four to six yards in the highest stage, follows very close to the workmen in the lower stage; and this mode of working under the fractured rocks, which formerly appeared doubtful, is now executed with complete success.

On the surface, the soil, which has a thickness of a hundred feet above the coal, sinks gradually and equally, and presents no abrupt fracture at the commencement of the line of excavation; cultivation receives no damage; and it is only in the case of a less thickness than a hundred feet, that the soil is ever broken abruptly into funnel-shaped cavities.†

The cost price of the coal of Blanzy, was, in 1839, 6*s*. 7*d*. per ton = $1.60. In 1843, it is quoted at nearly, 16*s*. = $3.87, and in 1845, at 7*s*. 3*d*. = $1.68.

The splendid coal beds of *Creusot* are renowned for the excellent manner in which they are worked. They yielded in 1843, 1,200,000 hectolitres, equivalent to 106,570 English tons of fuel. To this establishment five high furnaces are attached, and has so increased its manufacture of iron that, while in 1837 it produced only 3,500 tons, it could, in 1845, send forth from 15,000 to 18,000 tons of iron; thus quintupling its produce in eight years. The maximum depth of the works at Creusot, 870 feet.

In 1843, they employed fifty-five steam engines, having an aggregate of 1000 horse power, and the district furnished 163,000 tons of coal.

* Cosmos. Alex. Von Humboldt.

† Burat, Géologie appliquée, 411.

From the part of the establishment allotted to the fabrication of machines there are annually sent £120,000 worth of various machinery.

XXI. *Saône et Loire.—La Chapelle-saus-Dhun.*

A single concession, comprising an area of 750 hectares. It contains four coal seams, of the aggregate thickness of 27½ feet. Only two beds are worked, of 19½ feet; the coal is meagre, with long flame.

Produce in	1838	10,800 tons.
"	1842	12,750 "
"	1845	23,400 "

XXII. *Department of Allier—Coal-field of Bert.*

In the opinion of M. Manés, this coal-field probably is a continuation of the basin of Blanzy, which at its south-western extremity is covered with secondary and tertiary formations in the valley of the Loire, and reappears here. At this position the geological circumstances are similar; the coal formation possessing the same direction and the same composition.

The principal amount of coals consumed in this department is provided from three basins, situated in the same department; namely, those of Bert, of Fins and Noyant, and of Commentry; also from other regions.

The production of coals in the Department of Allier, from these three basins, in 1835 was 33,820 tons; in 1838, 56,460 tons; in 1839, 63,600 tons, and in 1841, 63,530 tons.

The basin of Bert contains two concessions, embracing a surface of 1712 hectares, and comprising three beds of coal, of which the principal, and the only one of importance, is eight metres, or twenty-six and a quarter English feet, thick; others are three to four metres thickness.

Production of the basin of Bert, in	1842,	14,720 tons.
" " "	1845,	15,300 "

XXIII. [*Allier.*] *Fins et Noyant.*

In the valley of the Queune, to the south-east of Moulins, resting upon granite, a depression of which it fills. It comprises four concessions, amounting to 3,337 hectares. Contains three principal coal seams, much disturbed. The most important is ten feet thick, of good coal, classed with the meagre coals, with long flame. Yielded in 1835, 20,000 tons; in 1838, 23,250 tons; in 1841, 10,000 tons; in 1845, 16,500 tons.

XXIV. [*Allier.*] *Basin of Doyet.*

An ordinance of the 14th Nov. 1844, authorizes the search for mines of coal over a district in the commune of Doyet; being 620 metres in length by 100 metres in breadth; for the duration of two years. The returns are generally included in those of Commentry. See table of analysis of coals n this basin.

XXV. [*Allier.*] *Commentry, Doyet, and Bezenet.*

In this coal-field is a bed of forty-five feet in thickness, which is nearly horizontal, and is wrought by open work in the manner of a quarry. The region acquires importance from its proximity to the Canal du Berry, to which it is united by a railroad. It is composed of four sub-basins:—that

of Commentry, and that of Doyet, Aumance, and Barre. Within this district are seven concessions, extending over 3,655 hectares, in 1845.

Besides the thick coal seam in the sub-basin of Commentry, there is one of three feet, and another of ten feet. In the basin of Doyet are six beds, the principal one is seventeen feet. There are several kinds of bituminous coal and one of anthracite. The aggregate thickness is sixty-five feet. A railroad conveys the produce to the canal of the Cher.

Production in 1838, 26,110 tons; in 1842, 49,391 tons; in 1844, 77,000 tons; in 1845, 104,000 tons.

XXVI. [*Allier.*] *Buxière-la-Grue.* One concession of 392 hectares. No returns.

XXVII. *Puy-de-Dôme—Saint Eloy Coal-field.*

A small band, in the valley of the Bouble, not more than three quarters of a mile in length, consisting of two concessions, of the area of 352 hectares. There are several coal beds of from three to six feet thick; the aggregate being forty-nine feet. Coal of inferior quality.

Yield in 1838, 2,460 tons; in 1841, 10,400 tons; in 1845, 41,000 tons.

XXVIII. *Puy-de-Dôme, Bourg-Lastic Coal-field.*

Contains two concessions; 1,471 hectares, with two coal seams in each; surrounded by primary rocks; aggregate, twenty feet of coal. One seam is true anthracite; the other a fat coal, with long flame.

Production in 1838, 560 tons; in 1845, 560 tons.

XXIX. *Departments of Haute-Loire and Puy-de-Dôme, Basin of Brassac.*

Coal Mines of La-Taupe.—The quality of these coals has been lately investigated at the laboratory of Clermont, under the direction of M. Baudin. It was desirable to throw some light upon the different composition of the several beds which had been at that time explored.

The fine specimens, reported upon, all form excellent coke, particularly that made from the coal bed, called La-Louise, owing to its great purity. We add these analyses to the nineteen other varieties of coal examined in the laboratory of Clermont, in 1841, and which appear in our tables.*

This was one of the early discoveries among the French coal-fields. In the year 1735 a powerful company was organized to concentrate the exploration of the mines of the basin of Brassac; but this design failed on account of the absolute dependence in which the ordinance of 1698 placed the adventurers, with regard to the owners of the surface.

It had, nevertheless, the effect of introducing some improvements, in the modes of working pursued, during a very protracted period, by the inhabitants of the country.†

This basin produced 33,200 tons of coal, in 1835, at 7*s.* 4*d.* per ton; in 1838, 46,340 tons at 7*s.* per ton; 1844, 57,000 tons; and in 1845, 64,000 tons at 5*s.* 10*d.* per ton, = $1.41.

The basin of Brassac contains eleven and a half English square miles,

* For analyses of the bituminous coals of the Departments of Cantal and Puy de Dôme, by M. Baudin, see Annales des Mines, Vol. I. 1842, and Vol. IV. 1843. The tables at the end of the present work exhibit the respective proportions of coke and of volatile matter in numerous coal seams in the basin of Brassac, and Puy de Dôme, in Auvergne.

† Résumé des Travaux, &c., en 1838, p. 15.

placed within a deep cavity of gneiss, which constitutes all the surrounding country. It comprises nine concessions, and an area of 4561 hectares; a great many beds of coal, varying from two feet, up to seventy-one feet, [twenty-two metres]. M. Baudin thinks that the seams already explored here, form but a feeble portion of those which really exist.

The beds of coal are generally from twenty-five to thirty feet thick. Those situated the lowest, or nearest to the primitive rocks, resemble anthracite, while the upper series are coking coals. These phenomena occur in several other basins; agreeing perfectly with the ideas which theory suggests as to the circumstances which have accompanied the formation of coal. At Charbonnier, the coal is analogous to anthracite. At Gros-Ménil, a single bed, almost vertical, presents a thickness of from thirty-three to fifty feet. At Mégécoste, four seams of very good coking coal, a little pyritous; altogether 27 metres = 88 English feet; at Celle, they are only thirty feet. These coals are known at Nantes under the name of the coals of Auvergne.*

Puy de Dôme.—Coal of the wood of Varazene, commune of La Besette, by M. Baudin.

Spec. grav.	1.400	Volatile products,	27.80
Tumid coke,	72.20	Grey ashes,	16.40

This is a fat coal, with long flame, employed in all the forges; texture, schistose. Four thousand tons were mined here in 1845.

XXX. *Puy St. Gulmier.—In the same Department.*

Anthracite, whose properties according to the analysis of M. Baudin, in 1844, are

Carbon, pulverulent coke,	87.00
Volatile products,	13.00
Ashes, light-grey colour,	16.40

XXXI. *Cantal, Basin of Haute Dordogne or Champagnac.*

In that part of the coal basin of Haute-Dordogne, which is called Champagnac, are the two mines of Lempret and Madic, in the arrondissement of Mauriac. The first of these mines embraces three coal beds, wherein the coal is distributed with extreme irregularity. The lowest occurs in lenticular masses, of which, that which has been worked is about one hundred and twenty feet long and thirteen feet thick. The second or middle bed is also lenticular, and about six feet thick. The third, or upper bed, possessing much the same character, has a maximum thickness of ten feet, in one mass; whilst another "rognon," remarkable for its form, is a true ball or sphere, about thirty-three feet in thickness, and a third is above sixteen feet in diameter.

The mine of Madic contains two beds, which produced 177 tons in 1835, and 670 tons in 1838. The basin comprises five concessions, and 3020 hectares.† Three coal beds, amounting to six feet thickness, produce schistose coals which belong to the class of fat coals, " à longue flamme."

XXXII. *Coal in the environs of Mauriac.*

There exists here a coal deposit, bordering the Dordogne, for a considerable length, which, although small, is not without importance. It is ascer-

* Magazine Pittoresque, June, 1846. † Annales des Mines, Vol. V. 1843, p. 136.

tained to contain seams of sufficient thickness, the working of which cannot fail to be very profitable. The coal of these seams is of very excellent quality; of a fine shining black colour and unequal fracture, with slight traces of pyrites. It would be proper for furnaces of boilers, but less so for the forge and high furnace.* Only fifty tons raised in 1845.†

XXXIII. *Coal Basin of the Loire. Sub-basin of St. Etienne.*

The basin of the Loire is the most important of the coal-fields of France, both as regards extent and geographical position. It occupies the space between the Loire and the Rhône; its greatest dimensions being 28½ miles. Geologically speaking, it is intercalated in a depression of primary origin, of which the walls are principally formed of gneiss. Towards the west and the north-west, it commonly reposes upon granite.

For a long period this coal-field was divided into two arrondissements; of which one, that of Rive de Gier, debouched upon the Rhône; while the other, that of Saint Etienne, had its outlet by the Loire. The introduction of railroads has changed this disposition, another coal of both groups now arrives, simultaneously, at the Rhône.

In 1831, it gave employment to 3053 persons, with 460 horses and 88 steam engines, of a power exceeding 2000 horses.

In 1835, there were 45 concessions, having an area of 42,038 English acres. It yielded, in that year, $\frac{45}{100}$ of the whole production of France, or 812,000 English tons.

In 1837, it supplied 47 departments with coal to the amount of	1,156,450
tons, and exported to seventeen foreign countries, - -	10,700
	1,167,150

In 1843, there were 203 pits, worked by 148 steam-engines, comprising 4678 horse power; employing 5,515 workmen, who extracted about 1,300,000 tons.

In 1846 it was covered by sixty-three concessions; thirty-three of which were in the sub-basin of Saint Etienne, and thirty in the sub-basin of Rive-de-Gier, and extended over 29,581 hectares.

The total superficial area of the basin of the Loire is estimated at 27,355 hectares, or 67,600 English acres. The production in 1846 was estimated at from fifteen to sixteen millions of metrical quintals, or 1,500,000 tons; of which the great mining company supplied more than two-thirds, or 1,100,000 tons. It has been calculated that the total quantity of coal, remaining within the basin of the Loire, is two hundred millions of metrical quintals, or twenty millions of English tons. This production, besides supplying the iron and other manufactories of the district, finds its way to Paris, Lyons, Marseilles, Mulhausen, Nantes, and various ports in the Mediterranean.

The sub-basin of Saint Etienne is the largest and richest of the two, into which that of the Loire is divided. The coal beds are fifteen in number, and vary from three feet to twelve feet each, in thickness. There are, even, beds that attain a much greater thickness; such as twenty-one, twenty-five, and even thirty-three feet.

In 1841, a careful examination of the coals of this basin was made in the Laboratory of the School of Mines at Saint-Etienne, by M. Gruner, from whose report we select the following details.

* Annales des Mines, Vol. VII. 1840, p. 567. † Conte Rendu des travaux, 1846.

The specimens were collected from the interior of the mines by M. Gruner himself, who had less care to seek for pure or rich fragments, than for those which represented, as nearly as possible, the mean quality of the mine or bed.

The author divided these coals into three classes, as follows:

1. Fat coals—very rich in carbon.
2. Ordinary coals of Saint Etienne.
3. Fat coals, burning with a long flame.

Of the first class, the coals are generally tender, and burn with a white flame, a little elongated. They give, by analysis, more than 72 per cent. of coke, the ashes being deducted: and the relation between the weight of the volatile matters and that of the pure coal without ashes, is, at the most, 0.25. As they enclose very little of earthy substances, they are particularly proper for conversion into coke.

These coals experience a singular alteration, from simple exposure to the air. It has been many times observed at Saint-Etienne, that the coals of Meons and Chaney, only yield a strong fine coke a short time after they have been brought to day; and that the small coal will no longer cement together in the coke ovens after one or two months' exposure to the air. These are very interesting practical facts.

It is further remarked that the gas produced by their carbonization, deposits but a very small proportion of soot. The various properties which have been elicited by these experiments, show evidently that they are highly carbonaceous; moderately rich in hydrogen; but, poor in oxygen. Their calorific power is considerable.

The mines which enclose these combustibles are all situated at the north-east limit of the basin of Saint-Etienne.

The second class comprehends the ordinary coal of Saint-Etienne: they are all very fat and caking, giving a very tumid coke.

Their use is regulated by the proportion of ashes which they leave after combustion. When they are pure [three to six per cent. of ashes] they are sought for the forge; and from these a coke of very good quality can be obtained.

When the proportion of ashes is more than six or seven per cent., the small coal is no more considered as fit for the forge: it produces only a coke of inferior quality, especially destined to feeding the high furnaces. Finally, when the proportion of ashes extends to ten or twelve per cent., it is excluded from the fabrication of coke; the coal then is sold for the service of the forges, of glass works, steam boilers, &c.

In the coals of this second class is found, by immediate analysis, always less than seventy per cent. of coke, cinders deducted; and even, sixty to sixty-six per cent.

These coals contain more hydrogen and more oxygen than those of the first class. They are situated in the concessions which prevail in the centre of the Saint-Etienne basin.

Third class.—The coals of the basin of Ricamarie comprise this class. These are the coals "*à longue flamme;*" less fat than those of the other classes, but harder. The large coal divides itself in fragments possessing a certain regularity, not easily reduced to powder. They resemble, to a certain extent, the *flena* of Mons; but they contain both more volatile matter and more ashes.

This coal is sought for the domestic grates and for the service of steam boats. The small coal supplies also the gas works of Lyons, &c.; and for

this purpose it obtained the preference over the other varieties, on account of the larger proportion of gas produced, which surpasses by a fourth that which can be obtained from the ordinary coals of Saint-Etienne. The abundance of ashes renders it little proper for the operations of the forge. It is sometimes made into coke; but it is very porous and friable; which circumstance, added to the large proportion of ashes, renders it even less proper for the fusion of iron ores in high furnaces. The smoke which proceeds from the coke ovens deposits much soot.

The coals of the third class furnish less than sixty per cent. of coke. The abundance of volatile matters, and the small tendency of the material to cake together, prove that these coals possess less carbon and more oxygen than the ordinary coals of Saint-Etienne; while the proportion of hydrogen is about equal.

Their geographical position is towards the south-east angle of the Saint-Etienne basin; all the beds of this district furnishing fat coals, "a longue flamme."*

A writer in the London Mining Journal, October 12th, 1844, observes, in relation to the capacity for supplying coal from this region, that should events ever bring about a war between England and France, the latter will need no foreign supply of coal, as the Rhone would furnish, from its mines near Lyons, all that would be required for the steamers of the Mediterranean, and the Loire for that of the ports of Nants, Bourdeaux, &c.; as would the canal navigation of the north furnish the coal of Valenciennes at Havre, &c. &c.† At Present, the coals for the steam marine of France are chiefly of British origin.

Prices of coal at the mines in the basin of the Loire.—1843, at the rate of 12*s.* or \$2.90 per English ton; 1845, at 6*s.* 2*d.*, or \$1.60, at the mines.

Statistics of the coal mines of the basin of the Loire—comprising those of the group of Saint Etienne, and the group of the Rive-de-Gier, now united.

Years.	Workmen.	Production. Tons.	Years.	Workmen.	Production. Tons.	Years.	Production. Tons.
1817	1,825	382,630	1828	2,190	657,130	1841	1,193,110
1818	1,915	384,780	1830	3,029	674,060	1842	1,290,415
1820	1,945	374,760	1831‡	3,053	625,490	1843	1,300,000
1822	1,959	415,540	1835		812,910	1844	1,234,800
1824	2,514	549,110	1837		1,157,150	1845	1,384,000
1825	2,814	503,340	1838		1,168,030	1846	1,500,000
1826	2,708	552,760	1839		1,116,900		

The average rate of annual extraction of coal per man, for fifteen years, from 1817 to 1831, is 206 tons, per annum.

XXXIV. *La Loire.—Anthraxiferous formation of Bully.*

The anthracite sandstone—*grès anthraxifère*—overlies, in the Loire, the schists of the silurian system. The principal *exploitations* of anthracite exist in the commune of Bully: and the formation in which they occur is a micaceous sandstone, which bears evidence of having been submitted to a very high temperature; a fact which is further proved by the absence of

* For details respecting *Coke*, and the *Kilns* for manufacturing it, see Vol. XX., 1841, *Annales des Mines*, p. 3 to 64, with numerous elevations, plans, and diagrams.

† Mining Journal, Oct. 12, 1844, p. 477. ‡ Annales des Mines.

volatile matters in the combustible, and even more completely so by the fact that some beds of feldspathic schist, entirely porcelainous, occur in the roof of a bed of anthracite.

Passing through a redish sandstone, [grès rouge,] in sinking their shafts, the miners reach a black earthy schist, intermixed with carbonaceous particles, but all much disturbed: then feldspathic schists, exhibiting the effects of igneous action. Finally, under these schists is found a bed of anthracite, about four and a half feet thick. Below this bed re-appear other sandstones; and the whole dips at an angle of 20° to 30° to the north-west.

The anthracite is of a greyish black color; moderately brilliant; burning without flame; containing but little volatile matter, and yielding white ashes.

Between Bully and Odenay the anthracite is traversed, and even elevated vertically, by dykes of quartziferous porphyry.*

XXXV. *La Loire—Basin of Roanne—Anthracite.*

Six concessions, and 4835 hectares. At La Bruyère, anthracite has been worked, and also in the vicinity, produced in 1845, 6,900 tons.

XXXVI. *Rhône—Ste. Foy-l'argentierè.*

In the little valley of la Brevenne. Ten thousand metres in length, by two thousand metres broad. A single concession of 1552 hectares. This basin rests immediately upon beds of gneiss and micaceous schists. There are three known coal seams here; the largest is about two yards thick; the others are mixed with schist, and not worked. Chiefly used in copper works.

Production in 1835, 7,460 tons; in 1838, 12,060 tons; in 1841, 14,830 tons; in 1842, 14,140 tons; in 1845, 15,500. Classed with the meagre coal with long flame.

XXXVII. *Department of the Rhône.—Basin of Rivè-de-Gier,*

Sometimes considered as a sub-basin of the basin of the Loire.

The administration has caused to be executed in the topographical bureau, established at Rive-de-Gier, a general map of this interesting coal basin, wherein the details of the seams of coal are represented with great accuracy, as the work of exploration advances. These details form the subject of a geological memoire by M. Meugy, from whence we derive the following information.

The coal basin of Rive-de-Gier, extends from the S. W. to N. E. between two chains of primitive mountains, of mica schists and talcose schists. Its breadth, in the centre, at Rive-de-Gier, is two English miles; whilst it is narrowed to about a fifth of a mile only, towards the north, and greatly expanded towards the south; the whole length being about seven miles.

There are ten coal-beds known at Rive-de-Gier, without counting that called *gentille*, which has not been recognized in the concession of Combeplaine. In thickness they range from one to thirty feet. Of this group, four beds only are worked, whose united thickness averages forty-five English feet.

* For the concession of the Anthracite Mines in the Communes of Bully, St. Maurice, Cordelle, and Dancè, see Annales des Mines, Vol. IV., p. 499, 1843:—Also several other anthracite concessions in that year.

M. Meugy arranges the coals of Rive-de-Gier in four classes, according to the uses for which they are employed, and which depend on their physical and chemical properties.

I. The coal "maréchale,"—very bituminous—proper for the forge and for coke.

II. The coal "demi-maréchale"—less bituminous—used in glass works.

III. Hard coal,—can be preserved a long while in large pieces; used for steamboats.

IV. Meagre, dry and schistose coal:—steam boilers, and in burning bricks and lime.

The main coal, called "*la grande masse*," which is said to average thirty feet thick, enlarges towards the centre of the basin, as is the case with the other worked seams, until at Grande-Croix, it attains a thickness of forty-nine, and even sixty-five English feet. The general position of this bed, is gently rolling, and unequally undulating; independently of the faults by which it is frequently disturbed, known to the workmen by the general denomination of "*crains*." We are not informed of the maximum depth of these pits; but the sections show that some of them are 300 yards deep.

It is much doubted whether the coal beds of Rive-de-Gier are prolonged to Saint-Etienne. The researches which have been made on the non-conceded lands, between these two positions, tend to the presumption that the beds of Rive-de-Gier do not extend so far; for the shafts, which have been sunk on the territories of Combe-Rigal and Plat-de-Gier, are already more than 400 metres,=1312 feet, deep, without having yet encountered any workable bed of coal. The determination of this question, which has been so much debated, is of the highest interest to the future prosperity of the basin of St. Etienne.

One observation, with respect to the coal seams of Rive-de-Gier, may be added. The inferior beds are, in general, much more disturbed [accidentées] than the superior strata: besides which, it is proved that the different beds are prolonged towards the south-west to a distance shortened in proportion as their formation is the more ancient.*

There are, at present, twenty-six concessions in this coal-field: the shafts or pits which they contain, are 205. It is traversed, longitudinally, by the canal de Givors and by the railroad from St. Etienne to Givors.†

M. Harmet, has furnished some notes on the working of the thick seam of coal at Rive-de-Gier. It was formerly the custom to excavate the coal in large chambers, including the entire height of the coal-seam, over a space 25 or 30 metres square, and to let the roof fall upon the part excavated, whilst the workmen prepared another chamber at another point, which was then cleared to a similar extent, and finally left to fall in, in the same way as the first. The results of this system were,

1st. Too great sacrifice of coal, because it was necessary to leave between the chambers, an unworked mass of coal: and 2d, much danger to the workmen, because the bed being twelve to fifteen feet thick, and the chamber comprised all this height, it was not possible for the miners, when the excavation was effected, to strengthen and support the roof, or even to ascertain the extent of danger to which they were exposed.

This system of working by chamber has been partially abandoned here, and is succeeded by a mode of working by "*remblai*," or partially filling up

* Thirty concessions according to M. Flachat.
† Annales des Mines, Tome VII. p. 67, 1845.

with rubbish, which is less dangerous to the workmen, and economizes the mineral contents of the mine.

Departmemt of Ain—Valley of Champromier.—Coal of the "calcaire liassique," and "marnes Irisees." Researches have been made in these formations for coal, according to M. C. Millet, but he thinks that they can never offer any chance of success.*

The coals consumed in this department are, for the most part, derived from the basins of La Loire and Blanzy, and some unimportant beds of lignite in Switzerland and Savoy, to the west and south of the Lake of Geneva.

XXXVIII. *Ain.—Lignite Basin of Douvres,*

Comprises four concessions and 2,110 hectares. Production in 1845, 700 tons.

XXXIX. *Isère.—Lacustrine Lignite Basin of Voreppe,*

Bordering the valley of the Roïze. This small area is based upon a thick deposit of rolled pebbles; indicating a period of calm, which succeeded to a period of violence and disruption. Among the fossil remains discovered within this fresh-water basin, are those of the mastodon; described by M. Charvet.†

XL. *Department of Isère, La Tour-du-pin, Lignite Basin.*

The fuel is conveyed by land carriage to the places of consumption, which are all situated in the proximity of the works. This department also receives, irregularly, a small supply of lignite from Chambery, in Savoy. Production in 1845, 16,500 tons.

XLI. *La Tarentaise, Department of Isère, Province of Dauphiny.*

On the east frontier of France, next the Alps, the anthracite of L'Oisans, occurs in several beds, which are described by M. S. Gras, Mining Engineer.‡ The same phenomena are illustrated in a paper by M. Gueymard.§

Among geologists, a great change has, by degrees, taken place, in assigning its true geological age to this coal formation. Dalomieu considered that it formed part of the primary series. In 1808, M. Brochant assigned the arenaceous rocks and argillaceous schists, with which the anthracite is associated, to the transition period, more recently known as the Silurian. In 1827, M. Elie de Beaumont, having discovered belemnites among a part of this series, came to the conclusion that it must be referred to the Lias formation, and in like manner the anthracitous formations of Savoy and Piedmont, and also beds of the same kind in Dauphiny and in other parts of the Alps.

These views, although adopted by many geologists, were not admitted without reservation by some others; principally on account of the character of the fossil vegetation which accompanied and distinguished the beds of anthracite. In fact, M. Adolphe Brongniart, having examined a great number of vegetable impressions collected from this district, found that they were identical with the most characteristic species in the true coal measures,

* Bulletin de la Société Géologique de France, Tome X. p. 91, 241.
† Annales des Mines, Vol. XVII. p. 211, 1840.
‡ Bulletin of the Geological Society of France, Vol. X. p. 91, 241.
§ Ibid., Vol. XI. p. 411.

and that, on the contrary, they had no agreement with the plants proper to the oolitic formations. We know also, that up to the present time, belemnites have not been met with below the lias.

M. S. Gras endeavoured to clear up this difficulty, and appears to have succeeded satisfactorily. He showed that the actual anthraciferous beds, in which the flora of the true coal-field appears, are associated with beds of gneiss and of talcose schists. Above these may be observed argilo, calcareous schists, which enclose belemnites and ammonites; and which, he agrees with M. Elie de Beaumont, are contemporary with the *Jurassique* age, or at least are not older.

From a series of careful geological observations, M. Gras determined that the anthraciferous beds are really subordinate to the gneiss and the talcose and feldspathic rocks, and that the Jurassique strata overlie them unconformably. They are distinctly shown to be so relatively placed in his sections. It is hence not to be doubted but the latter and older rocks are contemporary with the anthracite formation.

Finally it must be admitted that, as there is an intimate connection between the anthracite series of L'Oisans and the gneiss and talcose schists which accompany them, they ought both to be ranged under the same formation. Consequently, it is necessary to refer to the carboniferous period all the crystalline and, for the most part, the talcose stratified beds which, in Dauphiny, and generally in the Alps, have been considered, heretofore, as primitive.

The last part of these conclusions will doubtless, appear more extraordinary than the first. But the reasoning and observations of the author strongly confirm the opinion, already suggested by learned geologists, that the stratified granitic formations are, in general, *only sedimentary beds*, modified by subterranean emanations. In the Alps, where we have so many proofs of the violence and long duration of plutonic phenomena, the transformation, *en masse*, of the sedimentary rocks into crystalline beds extends as high up as the coal measures; unless, by an exception, as yet unknown to science, we are compelled to refer to this geological period an assemblage of beds which scarcely differ in any particular, from the best characterized primitive formations.*

The author is indisposed to agree with the suggestion of some geologists, that the lowest stratified beds might possibly appear in a reversed position; that is, folded back over the coal formation.

In a recent memoir, M. S. Gras remarks, that it is not in L'Oisans alone that anthraciferous schists are subordinate to the gneiss formation. The Department of Isere furnishes other examples. These instances are detailed by the author, but we cannot find space for them here.

We will mention, however, that near the village of Peychagnard, the passage of the anthraciferous sandstones into the talcose schists, said to be primary, is so apparent that it is impossible to trace a line of precise demarcation between them.

The unconformable position of the *calcaire jurassique* over the sandstone, has been proved lately by the exploratory works of the mine of *Rocher Hanc*. In this place is worked a bed of anthracite, 28 to 32 feet thick.

* In the Pennsylvania anthracite basins a rock of a remarkably dense and crystalline character often appears interstratified with the usual coal measures, and possesses many resemblances to rocks of a much older class. The metamorphic and talcose schists of the Rhode Island coal-field are yet more striking and analogous cases, in confirmation of M. Gras's reasoning.

Its upper part has for its roof, a crystalline calcareous bed, enclosing entrochi, belemnites and plagiastoma, constituting the lowest portion of the jurassique formation, but passing at a tangent from each other.

Respecting this locality of Peychagnard, we have some additional light furnished by M. M. Itier, M. Coquand and Dumas, illustrated still further by diagrams. Hence, we are assured that the sandstones and the anthracite beds which they contain, are almost vertical, whilst the lias beds, considered in the mass, form a species of dome or covering, approaching to the horizontal position.

This subject has received further importance from the visit, and the scientific inspection given to this region by the Geological Society of France, at the "*Reunion extraordinaire*" at Grenoble, in September 1840. Its members there studied, upon the spot, the details which had been presented to them in the memoirs of several of their contemporaries. They perceived that the talc schists and the anthraciferous sandstones equally belonged to one and the same geological formation.*

At this meeting M. Gueymard read a memoire on the anthracites of the Isère, noting the discordant opinions of his predecessors. He contended that the anthracite series was more modern than the schists and the gneiss, and more ancient than the limestones of the lias. M. A. Brongniart has been able to distinguish 22 different species of plants in the anthracite sandstones of Savoy and Dauphiné, of which number two only are strangers in the coal regions, yet do not belong to the lias. If these 20 species are identical with those of the coal measures, there can be no possibility of establishing a difference between the coal series and the anthracite beds of Isère; and the oldest assignable period for these is that of the grauwacke.†

We have extended our notices to some length, because they contain an admirable illustration of a philosophic investigation into one of the most difficult of geological problems. The recital is extremely useful in as much as it may be more or less applicable to phenomena that prevail in some other parts of the world. Something like this, whose details we have narrated, appears to be repeated with certain modifications on the North American continent.

Amount of anthracite raised here in 1845, 40,000 tons.

XLII. *Department of Isère, Basin of L'Oisans.*

Anthracite basin, eight concessions, containing 742 hectares. Production in 1837, 1,600 tons; in 1838, 120 tons; in 1835, 460 tons.

Commune of Monte-de-Lans, anthracite mine extending over 67 acres, called Mas-des-Combes

XLIII. *Isère, Le Drac, Anthracite Basin.*

Production in 1837, 22,000 tons; in 1838, 22,630 tons; in 1845, 40,000 tons. Price per ton at the mine, in 1845, 6*s.* 5*d.* = $1.54.

The anthracites of the valley of Le Drac, in 1838, were almost entirely conveyed by land carriage to the arrondissement of Grenoble, and thence on the backs of mules to the neighbouring communes. The produce of these mines is very useful to the country, on account of the scarcity of wood and of the rigour of the winters in that region.

* Bulletin de la Société Géologique de France, Vol. XI. p. 385.

† M. Brochant, Journal des Mines, Vol. XXIII. p. 321. M. Gras, Annales des Mines, Vol. XVI. p. 381. M. Gueymard in the Bulletin, Vol. XI. p. 49.

XLIV. *Haute Loire, Basin of Langeac.*

Yield in 1835, 22,880 tons; in 1841, 51,560 tons; in 1845, 2,800 tons. In the little valley of Marsanges, inclosed in primitive rocks. A single concession, that of Marsanges, amounting to 687 hectares, contains three beds of coal, from one to fifteen feet thick; schistose, but caking and of good quality, altogether twenty feet of coal. At present not extensively worked.

XLV. *Ardèche—Aubenas.*

Yield in 1835, 5,220 tons; in 1841, 10,040. This isolated basin is surrounded by granite, and furnishes, with a small part of the basin of Alais, the chief supply to this department. The greater portion of the coals here consumed is derived from the basin of la Loire.*

It contains one concession, and a superficies of 6061 hectares. The coal seams are numerous, but little pursued: they form veins rather than beds. There are eight beds, of about six feet each.

The coal is dry, friable, and anthracitous.

Production in 1845, 3,000 tons, mean price per ton 16*s.* = $3.84 at the mine.

XLVI. *Ardèche—Lignite basin of Banc-rouge.*

This small area of 1201 hectares, furnishes a portion of the fuel consumed in this department; but the greater part of the consumption is derived from the coals of the basin of the Loire.

In 1837 the production was not more than 1000 tons, and in 1845 only 550 tons. It is employed by the paper makers, in silk works, and limekilns.

XLVII. *Hautes Alpes—Briançon.*

Anthracite basin in the South of France, Dauphiny. Production in 1837, 2,160 tons; in 1838, 2,710 tons; in 1841, 3,160 tons; in 1845, 4,700 tons.

Beds of anthracite occur at very great heights in the Alps of Dauphiny, in a formation of schist and grauwacke, with vegetable impressions, reposing directly on the primitive rocks. Described by M. Hericart de Thury.

M. Ad. Brongniart has observed in the anthracites of Dauphiny and Savoy, among their fossil vegetation, twenty species of plants which are common to the bituminous coal formations; of which only two species had been seen in the former whose analogue he had not met with in the latter.

Such being the case, M. Gueymand remarks, if the agreement in the vegetation be so close, it is not possible to establish any difference between the true coal formation and that of the anthracites of Savoy, of Dauphiny, or Isère.†

The department of Hautes Alpes, consumes the anthracite which is extracted from her own soil, in the basin of Briançon and those of the basin of Drac. [Isère.] These anthracites, of which the use is gradually extending, are consumed by the domestic hearths and by limekilns. In 1838 this consumption was 3600 tons, for these purposes.

* Résumé des Mines, en 1838.

† Bulletin de la Société Géologique de France, tome XI. p. 419.

Draining Engine—Machine d'Epuisement of Rocher-Bleu.

In 1838, the working of the great lignite mines of Rocher-Bleu, Bouches-du-Rhône, being impeded by the increasing influx of water, and the works being at some points extended down to a depth which rendered it impossible to discharge such an influx with the means then existing, it became necessary to establish machinery capable of exhausting it; especially as the impediment prevailed in that portion of the lignite formation which had always furnished the best quality of coal.

It was only during the winter months that the mines were thus inundated. The water which then originated at the surface, penetrated with the greatest facility into the works, by means of the numerous fissures in the marly limestone which encloses the beds of lignite. It is by no means abundant during eight or nine months of the year; but during the rainy season, it augments in an enormous proportion. It was necessary that the machine, to be established at Rocher-Bleu, should have a power sufficient to keep the works constantly dry; for it is precisely during the winter that the coal of the country sells best at Marseilles.

Taking all things into consideration, it became obvious, that it would be imprudent to undertake the works of Rocher-Bleu, without first establishing an engine capable of raising at least three cubic metres of water,=105 cubic feet, English, per minute, from a depth of 125 to 130 metres [426 feet]. If the employment of such a power had been constantly necessary, it is certain that the expenses of exhaustion would have rendered it impossible to prosecute the mine to advantage. But as it was probable that during a great part of the year, only a fraction of this power would be required, it was hoped that an engine might be able to hold the works dry without the necessity of expenses out of proportion to the importance of the mine; provided always, that the engine, in performing that duty, should only consume a quantity of fuel about proportionate to the useful effect which it would produce at the time.

This obligation to apportion the consumption of fuel to the effect produced, to which several constructors did not believe it possible to submit, was however accepted by Mr. Phillip Taylor, constructor of machines at Marseilles; and by treaty with the company he engaged to have constructed in England, and to place over the shafts of Rocher-Bleu, an engine of simple effect, "*à cataracte*," and the pumps which it was designed to put in movement, on the following conditions:

1st. The engine shall have a power sufficient for raising 3 cubic metres, =105 English cubic feet, of water per minute, from a depth of 128 metres, =420 feet, English, giving not more than ten strokes per minute, and working at a pressure not to exceed three atmospheres.

2d. The consumption of fuel to produce this effect, not to exceed 200 kilogrammes,=440 lbs. English, of Newcastle coal, or 300 kilogrammes,= 660 lbs. of good lignite of the country, per hour.

3d. Finally, in the cases where the whole power of the engine would not be required, the consumption of fuel shall be limited proportionately to the effect produced; and that even to an extent descending down to the fourth of the maximum effect, that is to say, to a volume of water of ¾ metre,= 26 cubic feet, English, raised 420 feet per minute.

The results of the experiments to which this engine has since been submitted, have been published in Vol. XX. p. 527, of the "*Annales des Mines*," by M. Diday. According to an able notice in the same scientific Journal,

Vol. II. 1842, p. 3, "on the engine for draining the mines of Rocher-Bleu," also communicated by M. Diday, ingénieur des mines, and from which paper the foregoing sketch has been made, it appears that the engine had fulfilled all these conditions; and the writer proceeds to give a detailed description of the entire machine.

M. Diday concludes his first report by remarking—1st. That the engine, constructed by M. Taylor, presents several important improvements, which pruduce a considerable economy in the consumption of fuel. 2d. That M. Taylor has exceeded, in this respect, the promises which he had made; since in all the experience which has been obtained, the useful effect has been greater, and the consumption less than he had announced. 3d. That the construction of the pumps is equally very remarkable; since they give a real product, exactly equal to the theoretic product; a fact which is without example in the mines of France."*

XLVIII. *Basses Alpes—Lignite Basin of Manosque.*

The department is partially with its fuel by the lignite of Manosque. This combustible is transported by land carriage, for domestic uses, and for the burning of lime and plaster; the smiths' and farriers' forges also consume a certain quantity. Its area comprises 21 concessions and 5,906 hectares; producing, in 1845, 3,400 tons.

XLIX. *Vaucluse—Orange, Lignite Basin.*

Yield, in 1841, 8,300 tons; in 1845, 8,400 do.; the products are transported by land, and consumed within a circle around the vicinity of the basins of Orange and Méthamis—by the glass and silk factories, and for lime and plaster kilns.

L. *Vaucluse—Méthamis—Lignite Basin.*—Two concessions, comprising 5,516 hectares. Yield, in 1845, 2,300 tons.

LI. *Departments of Bouches-du-Rhone and Var—Lignite basin of Aix.*

Comprises twenty-two concessions and 29,242 hectares. The production in 1845 being 77,000 tons. It is in the valley of the Arc, near Aix, that the tertiary formations of the south of France attain their greatest development. The lowest part, rich in fossil combustible, is composed of alternating beds of bituminous limestone and of lignites, which are worked with much activity, at several points. This division is characterized by immense beds of fresh-water shells, tortoises, fragments of crocodiles, and their coprolites. To these may be added the remains of the mastodon.† Originally the lignite of the Bouches-du-Rhone was placed among the true coals, but its true position in the geological scale is now fully settled. What was thus supposed to be a true coal, was determined by Brongniart and other geologists, to occupy a much higher position in the series, and to lie in the green sand formation, or according to M. Dufrénoy, in the gres de Fontainebleau.

M. Coquand has undertaken to show that the tertiary gypsums of Aix, with which these lignite beds are associated, were contemporaneous with the gypsums of Montmartre. Among these lignites occur the trunks of palm-trees, with their fruits well preserved—Palmacites Lamanonis; fruits of coniferæ, leaves, flowers, &c.

* Annales des Mines, Vol. XX. p. 538, 1841; and Vol. II. 1842.

† M. Coquand in Bulletin de la Société Géologique de France, Vol. X. p. 77–82.

There are extensive mines of brown coal in Provence, about Marseilles and Toulon, where twenty-eight beds are wrought. Mean price per ton at the mine, in 1845, 9*s*. 3*d*.=$2.24.

Lignite beds of *Belcodène*—Bouches-du-Rhone. These are above the bed called the "gros rocher." Their analysis will be found in our tables: the ashes contain nearly half their weight of carbonate of lime.*

Lignites of the *Peipin*—Bouches-du-Rhone. Analysis by M. Diday:

	Mene du haut.	Bleu.	Menette.
Carbon,	43.20	47.60	49.70
Volatile matter,	45.60	48.60	47.20
Ashes,	11.20	3.80	3.10
	100.00	100.00	100.00

Lignite of *Rocher-Bleu*. M. Diday analyzed a specimen taken from the bed called the great mine. It is of good quality; burning with a beautiful flame.

It contains of Carbon, - - - -	50.20
" Volatile matters, - - - -	46.30
" Ashes, - - - -	3.50
	100.00

The principal, or great worked seam contains only a thickness of three feet of pure coal.

LII. *Var—Anthracite Basin of Fréjus.*

Yield, in 1841, 1,680 tons. In 1845, 4,900 tons of anthracite, and 1,900 of fat coal.

After eight years of exploration, a new coal basin was discovered in 1842, in the immediate vicinity of Toulon. The coal measures were reported, in 1846, to be 2,700 feet thick, and to comprise four seams of coal of three feet thick each, dipping to the north-west, at an angle of thirty-five degrees. But the coal is said to be of an inferior character, so far at least, as has been yet worked. Other seams are supposed to exist in the same series.

LIII. *Var—Lignite Basin of La Cardière.*

With the exception of a small quantity consumed upon the spot, the lignite of the basin of La Cardière is transported by land carriage three and a third miles to the port of Bandol; from whence it is sent coastwise to the islands of Porquerolle and Embiez. It is there employed in the manufacture of alkali. The area consists of one concession of 359 hectares, and the yield in 1845, was 1,400 tons.

LIV. *Var—Toulon.*—Concession of 404 hectares—no return of produce.

LV. *Var—Vescagne.*—Concession of 1,412 hectares—no return.

LVI. *Gard—Basin of Le Vigan.*

Meagre coal, with long flame. Yield, in 1838, 7460 tons. In 1845, 1,900 do.

The coal formation forms, near Vigan, two separate little basins, one only of which is of any importance, and is occupied by two concessions, com-

* Annales des Mines, Vol. XX. 1841, p. 310.

prising a superficies of 5685 hectares. Here are four beds of coal, two only are worked, from three to six feet thick, but sometimes enlarging to fifteen feet. The coal is "*maigre à longue flamme,*" with six or eight per cent. of ashes.

LVII. *Gard—Bagnols—Lignite Basin.*

These lignites are consumed in the arrondissement of Uzès, in the silk factories, limekilns, and domestic purposes.

Production, in 1845, 13,500 tons.

Assay of the lignite of *Saint Cristol,* near Alais—Gard, by M. Varin:

Carbon,	34.00
Volatile matter,	46.00
Ashes,	20,00

LVIII. *Departments of Gard and Ardèche—Basin of Alais, near Nimes.*

M. Varin has communicated a table of results of the examination of a series of specimens derived from different coal beds in this basin. These results are to be found at the end of this work.

This coal-field has only been worked since 1809, and is one of those on which the country can rely the most. It extends in length twenty English miles, by eight and three quarter miles broad, at the widest part; comprising twenty-two concessions and 22,394 hectares in 1845. It is subdivided by a chain of micaceous schist, into two sub-basins; that of Alais proper, and the basin of St. Ambrose to the north.

In 1842, extensive mines were brought into operation in this district, which supply Marseilles and the Mediterranean, at from 13*s.* to 15*s.* per ton cost,=$3.14 to $3.63. Near Alais, eighteen or twenty coal beds are known, and others are supposed to exist. Fifteen beds occur at Grand-Combe. The three concessions of Frenot, Grand-Combe, and Champelauson, possess together twenty-five beds, of an aggregate thickness of one hundred seventy-two and a half English feet. In the sub-basin of St. Ambrose are twelve beds, three to six feet thick each. The basin of Alais supplies coals of every species, but principally that called fat coal, "*à longue flamme.*" The production of the coal mines of the basin of Alais has rapidly increased, but the limits of the basin are not, even yet, traced with certainty, there being several detached or outlying portions.

	No. of mines or concessions.	Tons.
In 1835,	13	45,500
" 1838,	00	130,300
" 1842,	00	292,000
" 1844,	00	369,000
" 1845,	23	415,000

Mean price per ton, in 1845, 5*s.* 7*d.*=$1.35.

The area of land occupied by mining concessions was in 1838, 66,500 English acres. In 1845, 101,300 do.

The deepest mine is only two hundred and thirty-five feet. The coal seams are remarkable for their regularity; attaining to seventy-five feet in thickness, as that of Grand-Combe. They yield a moist coal, which makes a superior coke; and also a dry coal which burns without smoke or flame, and is therefore much sought after by breeders of silkworms.*

* Dictionnaire du Commerce, 1839.

There is an increasing export trade from this basin, by way of the Mediterranean. In 1845, this export amounted to 35,000 tons.

LIX. *Hérault—Basin of St. Gervais-de-Varensal, above Beziers.*

The bituminous coal and anthracite are likely to be worked to advantage in future here, for the Mediterranean supply. Hitherto the difficulty of transportation has prevented this district from becoming important. It is upwards of eleven miles long, the mean breadth being one mile. There are six concessions, embracing an area of 8,222 hectares. The number of coal beds vary, in different concessions, from five to eleven, whose greatest aggregate thickness is sixty-two feet.

The coal in the concession of St Gervais is dry, from excess of carbon, and approaches to anthracite. Production, in 1838, 18,000 tons. In 1842, 22,420 do. In 1844, 26,700 do. In 1845, 31,500 do.

LX. *Hérault—Ronjan.*

This basin reposes on transition schists and is covered by tertiary deposits. It contains three concessions, having an area of 7007 hectares. There are five beds of coal. The two which are worked are, together, about four feet; classed with the meagre coals with long flame.

This basin yielded, in 1838, 980 tons. In 1845, 4,100 do. Mean price per ton, in 1845, 6*s.*=$1.35.

LXI. *Hérault and Aude—Lignite Basin of La Caunette.*

The production of this basin is principally consumed in the vicinity of the works, or within the departments of Hérault and Pyrénees-Orientales. In 1788, the first regular permission for working lignite was granted for the basin of La Caunette. In 1846, it consisted of sixteen concessions, and 18,717 hectares. Production in 1838, 4,400 tons. In 1845, 4,500 do.*

LXII. *Aude.—Basins of Dourban and Ségure.*

At the eastern extremity of the Pyrenees, there exist two little basins under the above names, and each having a concession; together comprehending an area of 1759 hectares. The beds are directed from south-west to north-east, and in some places the divisions are formed externally of a porphyry.

Sub-basin of Dourban.—This little coal-field is one mile and a quarter long, by about half that in breadth: partly covered by the chalk formation, and resting on argillaceous transition schists. Only one bed of coal is known, the thickness of which varies from four inches to twenty inches..

Sub-basin of Ségure.—About two and a half miles long, and two-thirds of a mile wide. Here are four coal beds, of which only one, of three feet thick, is of importance, and is of an anthracitous character, classed with the meagre coals, with long flame.

A *pitch coal*, of a velvet black colour, is here a valuable article employed in manufacture. According to the Journal des Mines, twelve hundred men were employed, in fabricating with this pitch coal, rosaries, buttons, earrings, necklaces, bracelets, snuff-boxes, drinking vessels, &c. One thousand cwt. (quintals) are yearly expended for this purpose; and to Spain alone, the value of 18,000 livres is annually sold.

* Compte rendu des travaux, 1846.

Yield in 1835, 22 tons; in 1838, 1,360 tons; in 1841, 3,250 tons; in 1845, 1,500 tons.

LXIII. *Pyrenees-Orientales. Basin of Estaver.*

One concession of 3,174 hectares.

LXIV. *Department of Tarn.*

The coal-field of Carmeaux, situated to the north of Alby, has an area of 8,800 hectares, or 21,745 acres, in a single concession, and contains five beds worked, of a total thickness of forty feet; classed with the fat coals with long flame, and excellent in quality. Yielded in 1835, 18,420 tons; in 1841, 37,100 tons; in 1844, 43,600 tons; in 1845, 45,000 tons.

This district acquires importance from its proximity to the river Tarn, which enables the production to flow into the valley of the Garonne, and eventually to supply Bourdeaux.*

LXV. *Tarn.—Basin of Labruguière.*

Concession of 331 hectares; no returns.

LXVI. *Department of Hautes Pyrenees.—Commune of Orignac, in the District of Bayneres.*

Count Castellane has, during a long period, caused different points in the Pyrenees to be examined, in the expectation of finding veins of coal. At length a horizontal seam of bituminous coal has been discovered here, about ten feet in thickness.

LXVII. *Basses Pyrenees.—Coal Basin of Orthes.*

A provincial paper in France contains an account of the discovery of a coal mine at a place called *Surzaune*, near Orthes. The inhabitants were so delighted, that they went, *en masse*, with the local authorities at their head, to the church, to render thanks to God. They also indulged in noisy rejoicings. The mine, it is added, bids fair to be a very valuable one.

Anthracite.—At Jurançon, in this department, an announcement was made, in 1847, of the discovery of a bed of a species of anthracite—probably a lignite in a metamorphic state.

LXVIII. *Aveyron.—Basin of Aubin or Decazeville.*

A little above Rodez, eleven and a fifth miles long, and from two to five miles broad. It contains eleven concessions, enclosing a surface of 3,009 hectares. The principal coal bed is subdivided into three seams, by courses of intercalated schist. The superior seam is nearly one hundred feet thick in some of the mines, and thirty-three feet in most of the others. The middle seam is twenty-three feet, and the third seam is ten feet. On the north side of this basin are two other beds; and another to the east, of about fifteen feet.

The coal is classed with the fat coals, "*à longue flamme.*" The large seam resembles that of St. Etienne or Newcastle; but, nevertheless, of inferior quality to those.

* Magazin pittoresque, June, 1846.

Production of coal:—

Years.	Tons of 10.146 m. qu.	Years.	Tons of 10.146 m. qu.
1835,	119,150	1844,	155,000
1839,	125,700	1845,	163,000

Average price per ton at the mine, in 1845, 6*s.*=$1.35.

LXIX. *Aveyron.—Basin of Rhodez.*

It is nearly twenty-two miles long. In nearly all the ravines which exist on the left bank of the Aveyron, between Sensac and Bertholène, are found traces of the coal formation, the direction of the beds being constant to the south-east and north-west.

Nine concessions are located herein, inclosing an area of 3,845 hectares. It contains five coal beds; one of these, above six feet and a half thick, affords the best coal; the rest are thin seams, of dry coal. They are all classed as hard coals, with short flame, and somewhat inferior to those of Aubin. Production in 1845, 73,000 tons.

LXX. *Aveyron.—Basin of Milhau.*

Comprehends six concessions, with an area of 2,667 hectares. Its coal is classed with the lignites. It is consumed chiefly at Lodère and Montpellier. Production in 1845, 24,000 tons, for the use of the limekilns and domestic purposes of the vicinity.

These three basins, XLIX. L. and LI., produced in 1835, from twenty-three mines, 119,152 tons, at a cost of 4*s.* 1*d.* per ton. When the navigation of the Lot shall be improved, the coals can easily be extended to the valley of the Garonne and of the Gironde, as far as Bourdeaux.* Coal produced in the basin of Milhau in 1845, 24,000 tons.

LXXI. *Lot.—Basin of Tigeac.*

Now unproductive—yielding only 60 tons in 1835. Two concessions; no returns.

LXXII. *Les Landes.—Lignite Basin of Saint Lon.*

Being a forest country, but a small quantity of mineral fuel is required. The lignite of this small basin is consumed in the limekilns in the vicinity of Dox. The concession contains 301 hectares.

LXXIII. *Dordogne and Corrèze.—Basin of Terrasson.—Valley of the Vezère.*

Two concessions; area 2,355 hectares; beneath the "*Grès bigarré.*" Two thin seams of coal, of the quality called meagre, with long flame—adapted for puddling and casting. Yield in 1835, 1,000 tons; in 1838, 270 tons; in 1841, 130 tons; in 1845, 18 tons.

LXXIV. *Corrèze.—Argentat.*

Superposed on mica schist. Only one concession, which contains 1,139 hectares. Coal seam is four feet thick, of good quality, or fat, smith's coal, but often slaty; fat coal, "marechale." Yield in 1835, 1,760 tons; in 1838, 1,260 tons; in 1841, 1,620 tons; in 1845, 160 tons.

* Dictionnaire de Commerce.

LXXV. *Corrèze.—Meimac.*

This basin is only about 1,000 yards long, by 515 yards broad; enclosed in porphyroid granite. A single concession of 3,5∙0 hectares. The coal bed is three yards and a half thick, subject to frequent faults. Good smith's coal, occasionally sulphury; classed with the fat coals, "marechale." Yield in 1845, 1,600 tons.

LXXVI. *Creuse.—Bourganeuf.*

Contains three concessions, and an area of 1,231 hectares. In that of Basmoreau, several coal beds are worked, whose total thickness is about forty feet. They are classed with the meagre coals, with long flame. Coal used for grates and forges. Yield in 1835, 1,570 tons; in 1838, 1,730 tons; in 1841, 2,140 tons; in 1845, 50 tons.

LXXVII. *Creuse.—Basin of Ahun.*

Two concessions comprising 1,920 hectares. The rocks of this basin are re-composed from the debris of the adjacent granite. The basin is nine miles and a quarter long, and 650 yards wide. Its coal beds amount to an aggregate thickness of thirty-six feet; and are classed partly with the fat coals with long flame, and partly with the meagre coals. Production in 1845, 3,400 tons.

LXXVIII. *Vendée.—Bituminous Coal Basin of Vouvant.*

This basin reposes upon the transition schist which flanks the granitic chain of the Bocage. Since recent discoveries have led to the working of beds of coal adapted to the forge, it has become of importance. It only requires the facilities of economical transport, as far as the junction of the Sèvre and the Loire, to place these products, advantageously, on the shores of the ocean.

The Vouvant basin contains seven beds of coal, which crop out on the two opposite sides; the most important is six feet and a half thick, and is divided into two parts, one of which is a fat coal, the other a dry coal.

Besides the regular coal strata, and beds of carbonate of iron, M. Lechatelier has furnished the details and results of experiments on a third substance, the bituminous schist, which he demonstrates to be susceptible of application in the arts. This substance is already known in several parts of France, where it is mined for the fabrication of a mineral oil, which they now employ in gas lighting, and which is known in France under the name of the Selligue gas. The particular bed of schist here referred to, is near seventy feet thick. The mean result of the entire mass was found to be 6.17 per cent.; that of a portion of this bed shows at least 10 per cent. of oil on distillation; another experiment afforded 12 per cent.; a third 14½ per cent.* Produced in 1835, 500 tons; in 1841, 4,290 tons. Vouvant and Chantonnay produced in 1844, 12,000 tons; in 1845, 20,400.

This sub-basin of Vouvant is one mile long, forming the two sub-basins of Vouvant and Chantonnay, although, to all appearance, they are parts of the same deposit. They comprise five concessions, and an area of 2,096 hectares.

* Annales des Mines, 1841, Vol. XIX. p. 215.

LXXIX. *Department of Deux Sèvros.—Coal Basin of Chantonnay.*

This little basin was discovered in 1750. It is very narrow: not more than five miles long, in a north-west and south-east direction; but it is supposed that, in the latter direction, it extends even to the basin of Vouvant, which is only separated from it about four miles, and of which it would then be the prolongation.

The first researches, made in this basin, date in 1788; they were renewed only in 1827, but without leading to any result beyond a very thin bed of inferior coal. In 1838, further attempts led to the discovery of a bed which could be worked to advantage, and for which a concession was immediately procured. This coal seam is five feet and a quarter thick, but is divided by two small courses of shale, reducing its profitable area about one foot.

The coal of Chantonnay contains only one-twentieth of its weight in volatile matters; and, consequently, produces a large proportion of coke. It will probably serve, in its raw state, for the high furnaces; and the better because the stony matters it contains, being very calcareous, will take the place of a certain quantity of flux.* Yield in 1835, 500 tons; in 1841, 2,690 tons.

We know of three seams of from four and a half to six feet each, which pass through the length of this sub-basin, and two others of three feet.

The position of this basin is very favourable for supplying Nantes, La Rochelle, Rochfort, and the adjacent sea coast, as well as for developing the industry of the surrounding provinces; but hitherto it has been very imperfectly explored, and has not yet been entirely conceded.†

LXXX. *Maine et Loire, and Loire-Inférieure.—Basin of the Basse-Loire.*

This basin extends from the environs of Doué, [Maine et Loire,] even to Nort, [Loire Inférieure,] over a total development of sixty-three English miles. It contains ten concessions, which embrace a surface of 31,787 hectares.

In the southern part of the basin are ten coal seams, whose united mean thickness is forty-nine English feet. This coal is disseminated in lenticular spaces, instead of in sheets. On the left bank of the Loire the sum of the mean thicknesses is twenty-six feet; on the right bank it is twenty-three feet. At the north-west extremity, in the concession of *Languin*, the thickness is only six feet. The coals of Languin and Montrelais, particularly, are of the kind denominated caking coals.

The proximity to the Loire and the Nantes canal to Brest, confers great facilities on this region.

These coal beds, of which MM. Sentis and Lechatelier have published the analysis of nineteen, are supposed, by these geologists, to belong to the upper portion of the transition series, but they have not stated the evidence on which they found that opinion.

It will be seen by the tables of analysis, that the series comprehends both fat coals and anthracite; the former being very proper for the forge and for conversion into coke. In general the coals of the Maine and Loire are meagre, and a few of them approach, by their dryness, to the anthracites.

The coal beds of *St. Barbe* are intercalated in a system of beds of feldspathic sandstone, well known by the name of *Pierre carrée.*

* Annales des Mines, 1840, Vol. XVII. p. 554. † Magazin pittoresque, June, 1846.

Those of the *Bocage* form the principal resource of the mine of Layon et Loire. They are very irregular, sometimes exceeding thirty-three feet in thickness, and can only be worked with the Davy lamps. The details of these, and other coals of the district, will be found in our tables.

This was one of the early discovered coal-fields. In 1737, the first regular exploitations within the basin of the Basse Loire were established at St. Georges, Chatelaison.

Yield in 1835, 21,742 tons; in 1838, 31,920 tons; in 1844, 53,600 tons; in 1845, 52,000.

LXXXI. *Concession of Languin, near Nantes.*

Several veins of bituminous coal of a quality fit for iron making were discovered in 1841, through the enterprise of an English company. The object of this company was to make iron with coke and anthracite, and the excellent iron ore of this neighbourhood. The small quantity of coke-made iron heretofore smelted in France, and its very high price, as compared with English iron, appeared to render the success of the undertaking, of some national importance to France.*

The Mining Journal, May 22d, 1841, furnishes some details of the progress of this enterprise. The position of the coal mines is twenty miles from Nantes; extending seven miles along the range of the veins, which here take a nearly vertical declination, being 80°. They are three in number, varying in thickness, from twelve inches to sixty feet, which is the aggregate at the point of junction; the seams having been worked through, as one mass of coal in certain parts of the old workings.

This is said to be the only coal in the district of the Loire Inférieure, which is adapted for the manufacture of iron; and yields 60 per cent. of coke of fair quality.†

On this project an able report, by M. Fournel, subsequently appeared with reference to the expenses attending the making of iron here. From the data furnished by this and other reports, the editor of the Mining Journal calculates that the cost of a ton of iron, delivered at Nantes, will be £3; being even less than the duty imposed, (£3 7*s.* 6*d.* on English iron.) The price of English pig iron at Nantes being, at the same time, from £8 15*s.* to £9 5*s.* per ton, including duty. Mr. Geddes estimated the cost price of the Languin iron delivered at Nantes, at £4 16*s.* 11*d.* = $23.50. Messrs. Mamby estimating, on the contrary, that the cost at Nantes would be £3 12*s.* 6*d.* and by no means exceed £4, = $17.56 to $19.36 per ton. It was proposed that the iron should be for the most part, smelted with anthracite, brought from South Wales.

We allude to this matter here, because it is not the only case where it has been conceived advantageous to make iron in France, with the anthracite of South Wales. The excellence and cheapness of that fuel point out the fitness for its employment on the continent of Europe. The only question remaining is with reference to the permitting this coal to pass into a foreign country for such a purpose, leaving a corresponding bulk of iron ore unworked at home. We have not heard that this company have as yet made any arrangements further than for the sale of their bituminous coal.

As relates to the Languin coal, according to Mr. Geddes' report it is unusually soft and friable. He estimates the cost of raising it at from 10*s.*

* Galignani's Messenger.

† Mining Journal of London, Vol. XI. p. 164, 172, 388, 397. Also a report or prospectus published in Paris by Mamby, Brothers.

6*d.* to 12*s.* = \$2.56 to \$2.90 per ton. When delivered at Nantes, twenty miles, where it is much esteemed, it sells readily for 25*s.* = \$6.05 per ton. The uncertain and variable character of the principal seams in this locality form the greatest difficulty. Mr. Geddes states that there are not ten yards of coal uniform in thickness. A seam, which measured twelve and a half feet in thickness, being found, at 41 feet distance, reduced to only four feet, and at five feet distance in the opposite direction was entirely "nipped out."

By Mamby's Report, November, 1841, the cost of one ton of Languin coal was 10*s.*, and of one ton of coke £1 1*s.* 7*d.*, = \$2.42, and \$5.22.

	s.	*s.*	Dolls.
Cost of 1 ton of best Welsh anthracite, on board at Swansea, } " " " Pembrey or Llanelly, all large, }	8 to	9	= 2.18
Freight to Nantes, average the year		11.3	= 2.72
Cost to the exporter to Nantes,		12.0	= 4.90
The expenses on the French side are, import duty, 4*s.* 0*d.* } The octroi duty, 5*d.* } Unloading, weighing, and custom-house expenses, 1*s.* 2*d.* }		5.7	= 1.35
Welsh anthracite cost to the importer at Nantes,		17.7	= 6.25

The high furnace of La Jahotiere, in 1845, continued to be heated by Welsh anthracite, and by coke produced from the coal mines of the department.

LXXXII. *L'Indré et Loire, Department.*

Several eminent mining engineers have recently been employed in examining the coal measures of this department. It is ascertained that there are some very extensive coal seams, which, if worked, would greatly augment the mining and iron manufacturing interests here. Heretofore the great drawback on the prosperity of this region, in relation to its iron works, is the high price of fuel and the heavy expense of transportation. Thus it has been shown, that a certain weight of iron, of the value of £2 absorbs in its fabrication £1 in coal.*

Peninsular of Britanny or Bretagne.—According to Messrs. E. de Beaumont and Deufrenoy, this region presents three different systems of rocks, anterior to the new red sandstone.

1. The lower transition system, slate grauwacké, mica slate, and gneiss, (angers.)

2. The upper transition system consisting of sandstones, conglomerates, limestones, grauwacké and different slates; the latter containing beds of anthracite, sufficiently thick to be worked; as at St. Georges, Châtelaison, Montrelàis, &c. Some of the fossil plants are stated by M. A. Brongniart to be as yet unknown in the coal measures; while others are identical with those of the latter.

3. The carboniferous system, embracing the coal basins.†

* Mining Journal, 11th October, 1845.

† Cited by Mr. De la Bache in his report on the geology of Devonshire, p. 135, and no in support of his opinion that coal or anthracite beds were produced during the grauwac epoch, as well as in the period assigned usually to the coal measures. M. A. Brongniart seems to treat all this period as included under one epoch of vegetation, which commence d

Messrs. de Beaumont and Dufrenoy place the coal desposits of Bretagne in the Silurian system.*

LXXXIII. *Sarthe and Mayenne Anthracite Basin of Le Maine.*

Fifteen concessions and 30,357 hectares. Production in 1837, 41,000 tons. 1845, 95,000 tons.

This basin chiefly supplies the wants of the furnaces in the northern portion of the department, and in Mayenne; principally for lime burning.

Mean price at the mine, in 1845, 15*s.* 6*d.* = $3.75 per ton.

LXXXIV. *Mayenne.—Basin of St. Pierre la Cour.*

Mayenne, although rich in anthracite, has but a single small coal basin, of about a mile and quarter square. It comprises one concession of 539 hectares. There are several beds of fat coal, but they do not exceed two feet thick.

Yield in 1835, 6,200 tons; 1838, 11,200 tons; 1845, 15,200 tons.

LXXXV. *Mayenne—Anthracite mine of Bazouge de Chémeré.*

LXXXVI. *Finistèrre, Basin of Quimper.*—A very small return from hence, the whole area being 1816 acres in two concessions.

LXXXVII. *Departments of Calvadas and Manche, Basin of Litry in Normandy, between Isigny and Bayeaux.*

This basin comprehends two sub-basins; that of Litry and that of Plessis which have each a concession, amounting together to 16,342 hectares.

These coal mines were discovered in 1741.

It was in this same mine, in 1749, that steam was employed for the first time, in this kingdom, for the extraction of the coal, and for the drainage of the mines.

The coal of the Bocage was formerly considered to be of the transition age, as it rests upon the transition series. It is classed with the anthracites, and is chiefly used for lime burning. The sub-basin of Litry is again divided into two other little basins. Only a single coal seam is worked, whose mean thickness is five feet four inches. It is subdivided into three or four beds of different qualities.

Produced in 1835, 45,510 tons; 1841, 51,340 tons; 1842, 62,170 tons; 1845, 39,000 tons.

LXXXVIII. *Manche, Le Plessis.*

Produce in 1838, 5170 tons; 1841, 19,182 tons.

The sub-basin of Plessis contains two coal seams. The upper one is about 3¼ feet thick; the lower one is nearly six feet, and composed, like that of Litry, of several beds. It is a meagre coal, and good for little else than for lime and brick burning; but is generally classed among the anthracites.

as soon as emerged portions of the earth's surface became covered by a few plants, feeble and scarce at first, and attaining its maximum development towards the close of the coal period. Mr. De la Bache's views are unfavourable to the hypothesis of a sudden contemporaneous deposit of carbonaceous rocks over the globe, or any portions of it. See "Culm Region of Devonshire," in this work.

* Bulletin de la Société Géologique de France, p. 476, tome X.

STATISTICS OF ANTHRACITE.

In 1835, there were thirty-seven, and in 1839, forty-four, mining establishments of anthracite in operation in France; they are now more numerous. The beds are thick, and in some instances are above thirty-three feet; from whence the amount raised is annually increasing. Fourteen out of the seventy-four basins are now known to contain anthracite beds; the average price being $2.85 or 15 francs per ton, of both kinds of coal. Previously to that time the price at the mines was $0.96 cents; fr. 1.30, and fr. 2.00 per ton. In 1836, it had approached to $2.45, the demand having become greater for manufacturing purposes.

It is certainly a proof of the estimation in which this useful mineral is held in France, that while the annual amount of bituminous coal in the thirty years, from 1815 to 1845, increased four times, the anthracite, mined within the same period, increased one hundred times in amount, and one hundred and fifty fold in aggregate money value.

Of late years great progress has been made in the working of this species of combustible, the importance of which was scarcely known in France fifteen or twenty years ago.

M. Michael Chevalier has published in the "*Revue Generale*" of public works, an article "on the domestic use of anthracite;" and as the material abounds in France, it is there considered a subject well deserving of careful attention. This gentleman, who visited the United States of America for the purposes of science, states that the deficiency of bituminous coal on the eastern part of Pennsylvania, is supplied by large beds of anthracite, the use of which has now not only nearly superseded that of wood in Philadelphia, both in manufactories and for domestic purposes, but in most of the large towns in the eastern states. He describes its advantages, and the customary modes for using it, and arrives at the conclusion that it gives less trouble and is far more valuable than any other kind of fuel.*

The localities of the coal basins containing anthracite will be seen by referring to our table of the seventy-four coal-fields of France.

The anthracite mines in the environs of La Mure are the richest in this combustible; the beds being there more than thirty-three feet thick. In working these thick beds, the process employed is that termed by the miners, "*methode en travers.*" The works, instead of proceeding from low to high, are directed from high to low. This disposition is commended on account of the facilities afforded to the taking out of the combustible.

At Grenoble, Vezille Gap, and in a great portion of the communes of the Graisivaudan valley, anthracite is employed as fuel for domestic uses, for coppers, for nail factories, and for burning lime and plaster.

Several establishments exist in the department of the "*Hautes Alpes*" for mining anthracite. These have furnished employment, heretofore, to few others than the "*concessionaires,*" by whom the mines are held. It is during winter, or when they are not occupied in their fields, that these farmers work their mines. This simple and limited method is favoured by the disposition of the carboniferous beds, which are readily entered and worked by galleries, opening from the surface. On account of these circumstances, the price of anthracite is lower at the mines of the "*Hautes Alpes*" than any where else; in fact it is little more than the representation of the price of labour.

In the Departments of Mayenne and Sarthe, the anthracite occurs in

* L'Echo du Monde Savant.

irregular beds, or lenticular masses of various sizes, but never much prolonged. Heretofore, almost the whole of the anthracite obtained was sought for the purpose of burning lime. Its quality is variable and sometimes is slightly bituminous.*

Statistics of Anthracite Basins.

Table of the number of concessions for the working of *anthracite* mines in France, the number of workmen employed, the annual production, and the mean price per ton at the mine.

Years.	Number of concessions.	Number of workmen.	Tons of 10.1465 metrical quintals.	Value at the place of production.	
				Francs.	U. States dollars.
1814			5,680	8.01	1.55
1816			4,720	8.60	1.67
1820			7,400		
1825			23,374		
1826			24,960	9.80	1.90
1830			30,760		
1835	37		57,600		
1836	38	919	54,290	12.62	2.45
1837	40		68,280	9.63	1.86
1838	41	1,000	66,530	14,00	2.72
1839	44	1,216	83,230	15.00	2.85
1840			411,900	11.53	2.24
1844			571,720		
1845			569,900	12.50	2.41

Additional notices of localities of anthracite.—Beds on the right bank of the Loire.—Combres.—The outcrops of beds of anthracite and works, which are now actually in activity, occur at several points on the right bank of this river. For several years anthracite has been worked in the commune of Combres. There are at least two beds, but nothing positive can be affirmed on this head. The seam which is in work dips 15° or 20° towards the south, and is 4½ feet thick. This anthracite is very dry and schistose; intermixed with argillaceous matter, amounting frequently to fifty per cent. It is therefore less pure than that of Bully, and is only used by lime-burners.

Regny.—Anthracite has been worked here, but its volume is very irregular, and has been disturbed by veins of quartziferous porphyry, and by a thick bed of quartz. In the roofs of the coal beds occur, as at Combres, hardened sandstone, of a porphyritic appearance.

Vermoulin.—In the commune of Saint Claude, some proprietors have formerly explored this combustible. These ancient works seem to indicate the existence of several seams.

Valley of Ecorron.—Here also are some ancient workings. Four or five beds have been recently recognized; one of which is several yards in thickness.

Lay and Cassini.—Anthracite is worked at both these places, within the basin of Roanne.

* Traite de l'eclairage au Gaz. par Pelouze, Pere, Paris, 1839.

Brown Coal or Lignite, Stipite, &c.

This class comprehends all those mineral combustibles, whatever may be the position of their beds, which do not produce coke: which by calcination in an enclosed retort, leave a residuum always less in weight than fifty per cent., and which yields liquid matters which are rather more acid than alkaline.

Table of the number of concessions, their production and annual value, and the average prices of *lignite* per ton, at the places of production, in French and U. S. currencies.

Years.	Number of concessions.	Production. Tons of 10.146 quin.	Value. Sterling. £	Average prices.	
				Fr. Cts.	Dollars.
1814		23,086	9,161	9.92	1.92
1820		43,977	21,464		
1830		64,318	24,600		
1835	42	101,508	39,433	9.82	1.86
1836	44	96,240	36,514		
1837		97,540		9.63	1.83
1838		99,700		9.13	1.77
1839	48	99,860			
1840		115,142		10.30	2.00
1843		131,760			
1844		146,000			
1845	103	152,900	67,390	10.30	2.00

Lignite Basins.

Table of the productton of Lignite in France, from the official returns.

Names of basins.	Number of basins.	Departments.	1838.	1845.
			Metr. quin.	Metr. quin.
Aix, -	51	Var-Bouches-du-Rhone,	462,040	770,302
La Cardiere,	53	Var, - - -	25,850	14,365
Bouxwiller, -	8	Bas-Rhin, - -	128,642	79,686
Lobsann,	7	Bas-Rhin, - -	11,094	6,279
Bagnols, -	57	Gard, - -	105,002	135,729
Gemonval,	14	Haute Saône, - -		20,929
La Tour du pin,	40	Isere, - -	88,000	166,800
Orange,	49	Vaucluse, - -	65,809	84,507
Methamis, -	50	Vaucluse, -	16,535	23,714
La Caunette,	61	Aude-Herault, -	44,373	45,973
La Nied, -		Moselle, - -		1,850
Milhau, -	70	Aveyron, - -	25,660	24,500
Muyrancourt,	3	Oise, - -		25,988
Bourg, -	4	Aisne, - -	15,200	6,800
Dauvres, -	38	Ain, -		7,011
Manosque,	48	Basses-Alpes, -	12,161	34,128
Gouhenans, -	13	Haute Saône, -		91,463
Banc Rouge,	46	Ardeche, - -	10,520	5,500
Grand S. Denis,	15	Doubs, - -		6,800
			1,010,886	1,552,324

Departments of Lozère and Aveyron.

Examination of the Lignite of Rosiers (Lozère.)—For a long time the inhabitants of the commune of Rosiers, and of Peyrlau (Aveyron) worked a bed of lignite which is intercalated in the middle of the *Jura limestone,** at the junction of the two rivers Tarn and Lonte.

This bed, whose thickness is not more than 0m., 20c. = 8 inches, is overlaid by a bed of bituminous schist, 12 to 16 inches thick; and this circumstance renders the working (*exploitation*) practicable, if not easy. This lignite supplies the wants of the neighbourhood: it is even transported to Meyracis, where the mechanics and merchants burn it in their forges and workshops.

The following are the results of two analyses made of this lignite.

The first gave	carbon,	50.70	The second gave	carbon,	49.10
" "	volatile matter,	47.60	" "	volatile matter,	46.20
" "	ashes,	1.70	" "	ashes,	4.70

As we perceive, this lignite contains very little ashes: they are white and light. The coke is gray black, and spongy.†

Tertiary Lignites in the plastic clay and freshwater formations of Paris.

The lignites of the *Plastic Clay* of the Paris basin, consist of fruits, branches or stalks, and leaves; sometimes of monocotyledons, and very frequently of dicotyledons;—almost always of the family of palms, but never of that of ferns. This last circumstance is one of the most remarkable characters, and establishes a clear distinction between the ancient and true pit coal, and these more modern combustible fossils to which the name of coal is often applied. It is also distinguished by containing yellow amber. These lignites of Paris are associated with freshwater beds.

Sometimes the lignite is represented by carbonaceous impressions of leaves and stems, and by a black carbonaceous powder which colours the sand. The succinic resins are indicated by nodules of a bituminous appearance.‡

Lignite in the environs of Bayonne.—This is a good lignite, according to the examinations of M. Gruner, at the laboratory of Saint Etienne.

Concessions of lignite mines have been made in the departments of Tarn, and of Gard, &c.

Department of Marne.—Lignites are worked in the *calcaire grossier* of Orbais. M. de Guinaumont has described a section of these works.

The lignite occupies two beds. The upper bed is only eight inches thick; is without fossils, and is not worked. Beneath it is a sandy clay bed, five feet thick, full of marine fossils; and below it is the worked bed of lignite, exhaling a sulphureous odour, and enclosing marine shells.§

Department of Jura.—Lignite beds on the western declivity of the Jura mountains.

Lignite of the super-cretaceous formations.—With regard to the lignite deposits of the north of France, M. C. Prevost has expressed an opinion that they do not all belong to one epoch, that of the lower Eocene, anterior to the formation of the *calcaire grossier*, corresponding with the plastic clay formation of England. M. d'Archiac regards as contemporaneous and subordinate to the plastic clay, the tertiary lignites of all the localities which he has cited in the north of France, in England and in Belgium. As to those which may be traced in other geological positions the fossil species

* Calcaires Jurassiques. † Annales des Mines, Vol. IV. 1843, p. 178.
‡ Description Géologique des environs de Paris.
§ Bulletin de la Société Géologique de France, Vol. XI. p. 358.

which they enclose will always show the differences; and the circumstances of their deposition will further serve to distinguish them from any others.*

Other deposits of lignites of the tertiary age occur abundantly at Soissons, Opernay, Laon, and St. Paulet.

In the plastic clay beds of Gentilly and Arcueil, beneath the *calcaire grossier*, are seams of lignite, noticed by M. Duval, enclosing a great quantity of seeds and ligneous stems, partly pyritised, mixed with freshwater shells, and fragments of bones. M. C. d'Orbigny made known the existence of a thick bed of lignite, situated immediately above the plastic clay, in the commune of Gentilly.†

Upon the left bank of the Garonne, in the environs of Bourdeaux, and department of the Gironde, the central part of the tertiary group, overlying the *calcaire grossier*, or its representative, is distinguished by deposits of lignite and by collections of shells, worked under the name of *faluns*, for the improvement of the land.‡

Near Orbais, department of Marne, in the lower tertiary series, are several beds of lignites, which are worked.§

In the environs of Soissons, besides the beds of lignite, occur silicified wood, which has been identified as similar to that in the lignite state.||

Province of Isle of France, Department of the Seine-et-Oise.

The following notes are curtailed from the Memoir of M. de Saint-Brice, on the *plastic clay* and lignites in the commune of La Chapelle, canton of Magny, Arrondissement de Mantes.

Researches for beds of lignite here were undertaken during the year 1838, the period when M. Brice was charged with the service of that department.

The geological position of the deposit in question is above the great mass of chalk, and below the marine tertiary limestone "*à cerithes.*" Two or three beds were discovered by sinking pits or by boring. The quality was found to be good: it had much consistence; in some parts either dark, brilliant, and compact, or of a fibrous texture. It was, like all those of the plastic clay formation, a little bituminous; capable of burning without flame, but of developing a great degree of heat. It ordinarily emits a strong sulphureous odour. The proprietors were, in 1838, desirous of raising a sufficient quantity to prove its value in limekilns; also for a manufactory of tiles in the neighbourhood, and for domestic fuel and certain hearths of furnaces.

The lignite bed of La Chapelle en Vexin, is about horizontal, and five or six feet thick; capable of being worked to its entire thickness by means of galleries or levels opening into the air. At the extremity of the principal gangway [*galerie de service*,] it was proposed to sink an air-shaft, which, at a more distant period, might be appropriated to the purpose of raising the coal.

This combustible is known to exist in several parts of the department of Seine-et-Oise; and, being so near Paris, is of some value.

In some of these localities, some persons have been deceived by the first or external appearances; they regarded this substance as true coal. Applications for concessions of coal lands were twice made, which resulted in disabusing the authors of these demands, and in enlightening them on the real value appertaining to these lignites.¶

Isle d'Aix, near La Rochelle.—Lignite of the *green sand formation* or

* Bulletin de la Société Géologique de France. Vol. X. p. 159.
† Ibid., Vol. XI. p. 161—163, 164. ‡ Ibid., Vol. XI. p. 336. M. de Collegno.
§ Ibid., p. 358. || Annales des Mines, tome XVII. p. 460.
¶ Humboldt, Gissement des Roches, p. 294.

period. The wood is that of dicotyledonous plants, and it is remarked that no palms have been found herein.

At the same place is a *submarine forest* of dicotyledonous trees, sometimes bituminous and brittle, and again having the texture of Jet. These lignites are perforated by the teredo, and are accompanied by *amber*.

Cantal, Lignite of Mandailles; contemporaneous with the trachitic formations of the Cantal.* Analysis, or constituent parts:

Pulverulent coke,	43.90
Volatile products,	56.10
Ashes, white-grey,	4.20
	104.20

Specific gravity, 1.320.

Chambeuil, Lignite, subordinate to basaltic tuf—a bed three and one quarter feet thick.

Constituents,	Pulverulent coke,	44.90
	Volatile matters,	55.10
	Ashes,	6.80

Specific gravity, 1.320.

"Exploitation" of bituminous Minerals in France.—For the obtaining liquid bitumen and bituminous mastic.†

In 1838, the official returns were made from whence the following table has been compiled.

Departments.	Mines worked or unworked.	Number of workmen.	Mineral matters and productions.
Ain, - - -	1	51	Asphaltic Rock; bituminous mastic. The extract. of Seyssel asphalt more than quintupled, from 1837 to 1838.
Landes, - -	2	50	Bituminous sand; mineral pitch.
Puy de Dome, -	3	3	Bituminous schist and sandstone.
Bas Rhine, -	2	304	Bituminous sand, asphaltic limestone.
Haut Rhin, - -	1		do. not worked in 1838.
Saone et Loire,	2	20	Bituminous schist, for mineral pitch.
Concessions in 1838,	11	428	

Annual production of the mines of bituminous minerals, yielding bituminous mastic, mineral pitch, asphalt, calphonium and mineral oil,‡ and the annual value in French, English, and American currencies.

Years.	Number of concessions.	Number of workmen employed.	English Tons.	Value in Francs.	Value in U. S. dollars.	Value in £ sterling.
1834	6	224	740	195,677	37,960	8,166
1837	8	307	2,464	219,997	42,680	9,166§
1838	11	428	11,000	620,677	120,410	25,830
1839	13	416	2,721	415,026	79,100	17,291
1840	13	569	2,624	456,662	88,620	19,190‖
1844			3,290			15,108
1845	16	489	6,200	667,200	128,770	27,800

* Bulletin de la Société Géologique de France, 1844.

† The American reader is referred to a compilation on the subject of bitumen and its uses, and for details relating to bituminous mastics and asphaltes, by Lieut. H. W. Halleck, Washington, 1841.

‡ Compte Rendu des Travaux des Ingenieurs des Mines, 1834 to 1846.

§ Resume des Travaux statistiques de l'administration des mines, en 1838—1841.

‖ Bulletin de la commission centrale de statistique, Bruxelles, 1843.

Department of Bas Rhin—Bitumen Mines, near Strasbourg.

By royal ordinance, a grant has been made of the bitumen mines of Schwabwiller, in the communes of Nieder-betschdorf, Ober-betschdorf, Schwabwiller, and Haguenau; occupying seven square miles, English. The terms of this large concession embrace all the usual restrictions and provisions, relating to the preservation of buildings, canals, roads, and works, the public forests, the deposit of products, position of the openings, levelling the surface, and replanting with trees, on abandonment, which are noted under the head "Concessions and Royalties," herein.

The mine of Lampertsloch supplies a *bituminous sand*, from which petroleum or liquid bitumen is drawn. It is employed in greasing hydraulic wheels and axles, and for tarring cables.

The mine of Labsann produces *bituminous sandstone* and *asphaltic limestone*. From it they also obtain lignite, which is used as fuel. From late researches it is seen that there exist considerable quantities of *lignite* and *bituminous limestone* here.

Department of the North [du Nord] Aniches.—Asphalt and bitumen.

Beziers, [Department Herault].—Petroleum springs at the village of Gabian.

Les Landes.—Mineral pitch is extracted from the *bituminous sands* of this region, and is transported to Paris, where it is employed in the fabrication of bituminous mastic.

Saône et Loire.—There exist, in the coal basin of Autun, extensive beds of bituminous schist which furnish, on distillation, an oil which is employed for gas-lighting.* These works give employment to a number of persons. In this department are the three concessions of Dracy St. Loup, Surmoulin, and Millery, made in 1843.

Basses Alpes.—Beds of bituminous schist, belonging to the lignite formation in the environs of Manosque.

Daubs.—Bituminous schists Mouthier, belonging to the lias formation; worked for the extraction of oil destined for lighting.

Var.—Bituminous schist of the coal formation, in the environs of Fréjus.

Puy de Dôme.—Mines of bitumen exist in the commune of Pont du Chateau, and were granted in the year 1843, on payment of one-twentieth of the produce ground rent. Seven concessions also of bitumen mines at Lussat, at Des Roys, at Puy de la Bourrière, and at Malintrat, in the same department.

Puy de Dôme.—Petroleum springs at Clermont.

Bituminous Limestone of the Moys, Commune of Dallet, La Limagne, contains 22 per cent. of bitumen, according to the analysis of M. Baudin, and of all the rocks of the Limagne, approaches the nearest to Seyssel limestone. By reason of this great richness in bitumen the limestone of Moys submits to the action of heat, which liquefies a large proportion of the bitumen, and falls, under the least pressure, rather into a paste than a powder.†

Bituminous concretionary limestome of the Puy de la Bourière,—Commune of Lempdes.—Contains 19 to 21 per cent. of bitumen. On account of this abundance, this limestone would be usefully employed in the manufacture of the bituminous mastics.

Bituminous Oolitic limestone of the Puy de la Selle, contains 14 to 16 per

* Compte rendu des Travaux des Ingénieurs des Mines.
† Annales des Mines, Vol. XVIII. p. 733.

cent. of bitumen. This appears to be the only rock of La Limagne which abandons, in boiling water, a portion of its bitumen.

Mineral Bitumen or Mastic,—used for cement; obtained from the ***Puy de la Poix.****

Department of Ain.

Asphalt.—Not far from the mouth of the Rhone, occurs the celebrated asphalt of *Seyssel.* This substance has been more extensively and satisfactorily proved than any other variety of this class. It is largely used in France and in England, and has found its way into the United States of America; but it is too costly an article for common use there. The terrace of the Imperial palace at St. Petersburg has been paved with it; and the great Russian nobility have imitated the example of the emperor in its adoption.

The *bitumen of Seyssel,* known by the name of asphaltic stone, is nothing more than a calcareous oolite, impregnated with bitumen. To extract it from the quarries, the rock is broken to pieces, and is then melted in cauldrons, with six parts of pure bitumen. The product of this fusion, spread out in large rectangular slabs, takes the name of asphaltic varnish.†

No less than thirty varieties of asphalt have been offered, by companies, at the Bourse at Paris. That of Seyssel is probably the only one that will be profitable to the shareholders.‡

For the ordinance of 19th July, 1843, determining certain mineral rights in the concession of bituminous limestone of Seyssel, see Ann. des Mines, Vol. IV., 1843, pp. 632 and 707.

M. Millet has demonstrated that the bituminous limestones [asphaltes of commerce,] belong to the superior beds of the Jurassique formation, and particularly to the white coralline oolite. He proves that the introduction or penetration of the bitumen into the Jurassique limestone is effected from the surface into the interior of the rocks. The bituminous schistose limestones of Switzerland and Savoy, having the impressions of vegetables, among which the ***Zamiæ*** are abundant and characteristic, belong to a lower series; which is generally that of the Oxford group, and the limestones are more or less lithographic.§

The analysis of the "Calcaire Asphaltique de Seyssel," by M. Baudin, shows the presence of 10 per cent. of bitumen.

Concession of Orbagnoux.—This grant, made 11th July, 1843, comprises mines of bituminous limestones and sandstones in the commune of Corbonod.

Bituminous Minerals.

The quantity of fuel consumed in the production of these bituminous minerals, in 1845.

			Value.
Wood,	Steres,	6,193	32,960 fr.
Coal,	Met. qu.	184	828 "
		Total,	33,788 fr. = $6.521.00

Exportation of Bituminous substances, produced in France.

Years.	Mineral pitch or tar. Qu. Metr.	Asphalt. Qu. Metr.	Asphaltic rock. Qu. Metr.
1838	9,046	2,062	12,101
1845	1,860	34	34,616

* Ure's Dict. of Chemistry. † Office de Publicité.
‡ Mining Journal of London, Vol. X. p. 87.
§ Bulletin de la Société Géologique de France, tom. XI. p. 354.

Table showing the manufacturing establishments of liquid bitumen and bituminous mastic in France, in 1845–6.

Departments.	No.	Mines. Surface conc'd.	Manufactories.	Workmen employed.	Nature of the orginal substances.	Products. Nature.	Products. Weight. Qu. M.	Products. Value. Fancs.
Ain,	3	3,222	1	53	Asphaltic limestone of Pyrimont, Bitumen of Les Landes transported to Seyssel.	Rough asphaltic limestone, bituminous mastic.	32,559	117,251
Les Landes,	4	210	4	237	Bituminous sand,	Mineral bitumen,	16,980	424,500
Bas Rhin,		115	4	142	Bituminous mineral, limestone, Bitumen of Les Landes, Calphonium.	do. Bits. limestone, Calphonium, Bits. mastic,	10,894	97,401
Haut Rhin,	1				Bituminous sand,			
Saone et Loire,	5	3,025	4	57	Bituminous schist,	Mineral oil,	1,753	28.048
	16	6.572	13	489			62,186	667,200

The exportations of pitch are principally to Great Britain; those of asphalt to the United States, Belgium, and the German Association, and those of asphaltic limestone to Switzerland and Savoy.

Statistics of Peat.

Peat or Turf. Tourbe, Tourbière, Turbary.—This species of combustible, although held in the least estimation, probably, of any other, is, in France, as in Holland, Scotland, Ireland, and some other countries, of more value to the community than has been customarily assigned. It has been one of the objects of this work to point out the true value of this abundant natural production.

Official accounts of the amount of turf raised in France, and the number of workmen to whom the process gives employment, are annually published: but owing to the difficulty in procuring accurate statements, and to the irregular time and manner of working the turbaries in the communes, some uncertainty always prevails as to the details.

In some districts the turf is solely applied to the domestic purposes of the inhabitants. In others, on the contrary, the exploitation of the pits gives rise to considerable works; and this fuel furnishes a supply to various important industrial establishments, such as sugar houses, distilleries, dyehouses, steam engines and boilers, and kilns for lime and plaster; and it is even employed, although to a limited extent, in certain iron works.*

The quantity of peat annually raised is greatly on the increase in France, Austria, Bohemia, Bavaria, Styria, Wurtemberg, and other parts of Germany, in consequence of recent improvements in its application to the smelting and fabrication of iron.

In France, the Tourbières which belong to individuals continue under the general surveillance of the Engineers of Mines; while the "exploitation" of those which are public are under the immediate control and direction of those officers. In several departments, where the importance of these peat beds requires a general and systematic mode of extraction, the working of the turbaries is subject to the special rules of the public administration.

The following statement exhibits an account of the extraction of peat in

* Compte rendu des travaux des ingénieurs des mines, 1846, &c.; also Résumé des Travaux Statistiques de l'administration des mines.

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France, for some years past; and includes the number of turbaries and workmen, the number of English tons annually raised, and their value in French, English, and American currency.

Years.	Number of pits worked or not in work.	Number of workmen.	Weight in English tons.	Value in Francs.	Value in dollars.	Value in £ s. d.	Mean value per ton. Fr. C.
1834	1,958	34,762	355,600	2,995,738	578,177	124,822	8.42
1837	2,293	36,614	426,700	3,989,189	771,200	166,210	9.32
1838	2,499	36,958	390,000	3,482,770	673,330	145,115	8.93
1839	3,732	41,703	412,300	3,817,454	736,768	159,060	9.25
1840	2,504	45,870	440.830	3,652,015	704,840	152,169	8.31
1842	2,527	59,000	656,000	5,326,184	1,029,720	221,924	8.21
1843	2,973	46,249	454,276			189,919	
1845	3,433	38,562	520,000	5,065,122	977,560	255,046	9.70
1846	3,120						

In point of weight, therefore, the annual amount of peat is about ⅛th of all the coal, anthracite and lignite raised the same year in France, and in value it is one 7½ of the whole.

Quantity of turf employed in the iron works in 1838, 7,120 steres,= 12,508 francs value; 1844, 7,540 steres; 1845, 1,684 tons,=19,657 francs value.

Charente.—The turbaries here are daily acquiring importance, on account of the employment of their produce in the steam paper-mills of this department, and are replacing the coal previously imported from England. It is generally admitted that it requires three parts of turf, in weight, to replace one part of the coal.

Pas-de-Calais—In this department, where the turbaries are of great importance, the efforts of the engineers have been directed to the extraction of the peat in the completest manner, and in the mode which is acknowledged to be the most suitable.

Somme.—The price of turf in 1846, was gradually diminishing, on account of the continually-increasing consumption of coal for domestic uses; at the same time the price of the ashes of peat increased remarkably; by reason that these ashes are more and more in demand for the purposes of agriculture, not only in the department but those adjoining.

Analysis, characters, and localities.—Some occasional analyses and description of local deposits of this fuel occur in the *Annales des Mines*, and other scientific works to which we have had access.

Peat of Sécheval.—M. Sauvage examined this substance in the laboratory of Mézières, and in 1841 communicated the results, of which the following is the substance.

There exist in the arrondissements of Rocroy and of Mézières considerable beds of peat, which are worked for domestic uses. The greater part of these deposits occur at elevated levels, on the plateaux of the Ardenne: the remainder are seen at the sources of nearly all the streams, and in valleys of adequate breadth. In point of quality, the peat of Sécheval is considered the best.

It is brown, and compact; weighing, after having been dried in the air, 300 kilogrammes per stere; [=661 lbs. English for each stere of 353. cubic feet Fnglish, which is 505 lbs. to one cubic yard: being less than one fourth the weight of the lightest bituminous coal.—T.]

The analysis shows the following composition:

Carbon,	22.0
Combustible volatile matter.	39.2
Ashes,	8.3
Water,	30.5
	100.0*

Peat of the Valley of the Bar—Analysis of the ashes.—They are of a rose colour, very light and very hygrometric, and the results of M. Sauvage's investigation are very interesting. The relative proportions of mineral substances in a given amount of ashes are as follows:

Carbonate of lime,	19.55	39.30
Sulphate of lime,	13.25	
Lime,	6.50	
Argil,		21.20
Alumine,		9.50
Silicia,		15.50
Oxide of iron,		11.15
Magnesia and alkalies,		2.60
		99.25

In this case, it is remarked that, these ashes contain too large a proportion of sulphate of lime to render it possible to employ the peat advantageously in the smelting of iron ore. But they would be excellent if applied to agricultural purposes.†

Peat of Lauzanier, Basses Alpes.—This valley, situated to the north-east of Barcelonnette, near the frontiers of Piedmont, contains several tourbières, some of which have been attempted to be worked. The peat occurs in unusually small beds, the thickness of which do not exceed ten centimetres,= four inches. It is doubtful whether so very small a bed can be worked to advantage. See table of analysis.

Department of Meurthe.—Peat is here one of the principal natural products.

Peat employed in making alum and copperas, 1838, 36,400 sterès= 25,550 frs. value.

In the peat-moss of the Somme, at Vseux, not far from Abbeville, in the north of France, oaks have been found that were fourteen feet in diameter; a size which, in the old hemisphere, beyond the tropics, is very remarkable.‡

Peat for gas lighting.—According to the experiments of M. Merle, the advantages of peat for this purpose, are

1st. It is less expensive than gas made from coal, oil or resin.

2nd. The produce is nearly as great.

3rd. The gas is quite harmless and inoffensive.

4th. After having been used for gas, it is still applicable as fuel, to an extended degree.

See numerous notes regarding the properties and uses of peat, under the heads of Ireland, Scotland, Holland, German States, Austria, Bohemia, United States, Newfoundland, &c.

See also American Journal of Science; also Dr. Emmons on the uses of peat, in his annual Geological Report of New York, 1839.

* Annales des Mines, Vol. I. 1842, p. 521—523.
† Also for analysis of the Peat of the Bar, Vol. XIII. p. 52.
‡ Cosmos—A. Von Humboldt.

Ordinance, 5th August, 1844, relative to the working of tourbières.*

All proprietors of turbaries who wish to continue or to commence the working of turf, must first of all make declaration and obtain permission.

These permits [autorisation] will only be effective during one season: it must be renewed by the prefect, annually, on the demand of the proprietor, and on report of the engineer of the mines of the department. The declarations concerning them, must be addressed, three months before the commencement of the works, to the sub-prefect, through the medium of the mayor of the department.

It is obvious that these, and all similar regulations in the practical pursuits, are embarrassing to the parties engaged in them, and their utility is very questionable.

Les Landes—Peat employed for manufacturing iron.—Iron works of Ichoux in Les Landes.

According to M. Lefebvre,† the proportions which result from the operations at the refining and puddling furnaces and forge operations at these works, chiefly through the use of peat, are as follows:

114 kilog. pig iron produce 100 kilog. of puddled iron, with 242 kilog. peat, and 52 kilogs. wood.

116 kilog. puddled iron produce 100 kilog. of bar iron, with 93 kilog. peat, 37 do. wood, and 9 do. coal.

The peat of Ichoux contains two and a half times more ashes than the peat of Kœnigsbronn, in Wurtemberg, there also employed in iron making.

In 1842, the establishment of Ichoux was the only one in France in which peat was employed for converting cast iron. There are, however, a great number of forges in the vicinity of the turbaries, which are able to procure this combustible at a small price; and with the example of Kœnigsbronn before us, which has been regularly and satisfactorily conducted, during many years, by M. Veberling, we can no longer permit ourselves to doubt the advantages which are presented by the employment of peat in the fabrication of iron.‡.

The sand of the Landes belongs, according to M. de Collegno and M. de Dufrénoy, to the upper part of the tertiary group.§

Iron making by means of *gas* obtained from *peat*. This is now practised in France, Germany and Sweden, and may be very advantageously employed wherever mineral fuel is scarce and where peat beds are abundant.

Combustibles consumed in the Iron Manufacture in France.

We insert below a table of the quantity and the cost, or increased value, of the different descriptions of combustible employed and consumed in the twelve iron making districts of France, in the production of pig iron, and in the fabrication of bar iron and steel, *at the places of consumption;* and also the number of workmen employed.

These details are derived from the official sources.‖ For the convenience of the reader, and to facilitate the means of comparison, we have calculated the data in English measures and weights, and in English and American currencies.

* Annales des Mines, tome VI. 1845, p. 646. † Ibid., 1839, t. XVI.
‡ Annales des Mines, 1842, Vol. II. p. 787.
§ Bulletin de la Société Géologique de France, tome XI. p. 337.
‖ Combustibles consommés dans la fabrication et les élaborations principales du fer, de la fonte et de l'acier. Résumé, &c., 1836 to 1844. Traité de la fabrication de la fonte et du fer, Flachat, 1845.

Description of Fuel consumed.	Measure &c. 1836.	Measure &c. 1838.	Measure &c. 1840.	Measure &c. 1841.	Measure &c. 1844.	Tons. 1845.*
Coals, Tons.	232,390	601,950	411,140	349,270	494,750	653,000
Coke, Tons.	112,380	104,930	171,210	175,920	241,000	316,000
Charcoal, Tons.	598,850	608,700	545,120	594,410	608,700	565,000
Wood, Steres.	34,060		287,990	176,650	263,400	300,000
Peat, Steres.		7,125	11,260		7,540	1,680
Value in Pounds,	£2,039,760		2,226,930	2,179,660	2,346,680	2,422,410
Value in Dollars,	$9,671,470		10,689,260	10,162,380	11,264,060	11,413,620
Workmen employ'd	43,775	44,242		47,830		50,030

Miscellaneous Table, chiefly in relation to Iron making.

The sum total of all the branches of mineral industry in France, in 1845, was as follows:

	Worked.	Not worked.	Total.
Number of mines, quarries, &c.	27,094	2,761	29,855
Number of Usinès, active and inactive,	15,559	465	16,024
Workmen employed in all departments,			297,126

Value of all the branches of mineral industry,	*Fr.*	434,908,729
Value of the five species of combustibles, including turf, consumed in the iron founderies, &c., in 1845,	*Fr.*	59,137,973
Value created by the fabrication and principal elaborations of the foundery, of iron and steel, in 1845,	*Fr.*	166,112,783
Weight of iron ore extracted, in 1845,	Tons.	2,406,000
Weight of pig and cast iron, in 1845,	Tons.	438,900
Weight of steel, in 1845,	Tons.	10.700
Weight of forged iron, in 1845,	Tons.	342,200
Value created by the extraction and preparation of the iron ores,	*Fr.*	15,150,639
Foundry and pig iron,	*Fr.*	106,214,798
Principal elaborations of the pig iron and foundry,	*Fr.*	36,236,349
Principal fabrication and elaboration of steel,	*Fr.*	8,510,997

Wood in France.—Comparative Consumption of the Vegetable and the Mineral Fuels.

According to official returns in 1838, it is seen that the forest surface of the kingdom occupies 8,521,100 hectares, of about two and a half acres each; or about three and one-third millions of acres; of which five-eighths belong to individual owners.

France possesses, besides, a considerable amount of lands, pastures, and heaths, derived from the demolition of ancient forests, estimated at 7,799,672 hectares more. These lands produce a certain quantity of wood, thickets and bushes, from which domestic economy, and some branches of industry, often derive a useful portion.

The produce of the forest lands is estimated at 35,433,368 steres. Of the second class, including all descriptions, 20,000,000 steres; total, 55,433,368 steres; which, at two and three-fourths steres to each corde of eighty cubic feet, is 20,340,000 cordes, annually is produced.

Of this quantity it is estimated that there is consumed, for constructive

* Compte rendu des travaux, 1846. Table 9, p. 66. Table 3, p. 65. Also p. 16.

works, marine, military, and civil, for carpenters, coopers, wheelwrights, and numerous other purposes, one-fifth, 4,068,000 cordes.

Employed as vegetable combustibles or fuel, in France, four-fifths, or 16,272,000 cordes. Add to this the excess of imported over exported wood, 149,400 cordes; total, 20,489,400 cordes.

A stere of cord-wood being equivalent to 180 kilog. of coal, it is ascertained that the calorific power of the vegetable combustibles, annually consumed in France, is equal to that which is developed by the combustion of 80,599,437 metrical quintals, or nearly 8,000,000 tons of mineral fuel.*

The amount of mineral fuel consumed in France, in the year 1847, was 6,500,000 tons. It consequently furnished about four-ninths of the total quantity of heat expended, in the kingdom, for domestic purposes and for industrial operations.

As the consumption of mineral fuel in the interior augments with greater rapidity than that of wood, it follows that the time is near at hand when this mineral consumption will be quite equal to that of wood.

The considerations growing out of these facts, it is remarked in the report of the minister of public works, and the certain importance derived by the employment of the mineral fuels, amply indicate that the exploration of collieries will speedily exert over the national industry an influence at least comparable with that of the forests.

In 1828, it was reported by M. le Baron Pasquier, in behalf of a commission appointed by the government to inquire into the state of the iron trade of France, that in that year the total value of vegetable fuel used in the iron forges was about thirty millions of francs. In subsequent years the comparative value of vegetable and mineral fuel was as follows:

Years.	Vegetable Fuel.	Mineral Fuel.
1828,	£1,250,000	
1836,	1,657,560	£382,207
1841,	1,748,040	431,624
1845,	1,667,900	796,100

In 1844, the quantity of wood [of which the greater part was cut from the Royal forests] consumed by the furnaces of France, was 9,264,464 steres; that is to say, the metallurgic works employed more than one-fourth of the total production.

Public attention has been called, of late years, to the increasing demands for fuel from the Royal forests, which are now cleared of timber to an alarming extent; and means have been suggested for re-planting those areas, and for placing them under a more efficient system of preservation.†

It will be seen, by the foregoing table, that in 1845 the value of the mineral fuel had increased greatly, in proportion, and then amounted to about one half of the value of the vegetable fuel, which was employed in the iron works of France.

Torrefaction of Wood, for the use of the high furnaces in France.—Those who desire an acquaintance with the details of this process will derive much information from the Memoire of M. Sauvage.‡

A stere of wood produces, on an average, 68 kilogrammes, 40 of charcoal.

* Résumé des travaux statistiques de l' aminisdtration des mines en 1838, p. 11.

† Memoire sur le reboisement et la conservation des bois et forêts de la France; par M. Allusud, 1845.

‡ Memoire sur la fabrication en forêt du bois torrefié. Annales des Mines, t. XVIII. p. 677.

Employmont of Wood in Iron making.

Among the advantages of vegetable fuel may be enumerated the superiority of the metallurgic products and results; but a set-off to these exists in the high price of this description of fuel, in France, an objection which heretofore has been scarcely felt among the vast forests of North America. Amongst other projects for keeping up an undiminished supply of this fuel, plans have been urged for the re-planting [reboisement] of the public and private forest lands, now much dilapidated in France.

The area of forest land in the vicinity of the principal iron works is reported at 6,647,902 hectares=16,426,970 English acres, which it is proposed to divide iuto twelve different groups.

Besides the timber of her own growth, and which is found inadequate to her increasing wants, France annually imports timber to a large amount, of various descriptions, the value of which will be seen in the following table:

Years.	Importations. Millions of Francs.	Exportations. Millions of Francs.
1827	20.4	3.0
1828 to 1837	24.0	3.5
1838	31.9	4.3
1839	34.5	4.7
1840	34.9	5.2
1841	38.4	4.1
1842	45.3	4.5
1843	43.3	4.8

Still, the consumption of wood in the manufacture of iron has, for obvious reasons, not kept pace with the increased make of that metal. We have tables before us which show, that while the consumption of coal for the same purposes has greatly increased in France, that of wood has remained very nearly stationary for several years. The average annual supply from the forests to the iron works being as follows:

Of wood, about 250,000 steres, at *fr*.5.40 per stere, } Delivered at the
Of charcoal, 600,000 tons, at *fr*.72 per ton, } works.

A striking exemplification of the immense importance of an adequate supply of combustible, whether vegetable or mineral, to meet the rapidly enlarging demand for the use of the steam engines alone, employed in metallurgic processes, in manufacturing, in steam boats, and in locomotive engines, appears from the following statement:

The steam engines in operation throughout all France were equivalent in power, in

		Horses.		Working men.
1840,	to	143,706	or to that of	1,005,942
1843,	to	177,306	or to that of	1,241,142
1845,	to	218,799	or to that of	1,531,593

The supply of charcoal is said to be on the decline, from the gradual exhaustion of the forests; to obviate which large importations are received from the wild and still extensive forests of Germany.

The following table shows the quantity of fuel periodically consumed in the furnaces and foundries, for making iron, cast metal, and steel, throughout the kingdom of France.

Years.	Mineral Fuel.	Vegetable Fuel.		
	Coal and Coke. Tons.	Charcoal in Tons.	Wood. Steres.	Turf. Tons.
1836	344,780	593,850	34,060	
1838	601,950	608,700	104,930	
1840	582,350	545,120	287,990	
1842	597,930	596,470	207,780	
1844	735,750	608,700	263,400	
1845	823,000	564,000	220,000 tons.	620*

Hence, it is seen that the consumption of wood still forms the larger portion of the fuel which is employed in the metallurgic processes of France; but that the increased supply, drawn from the mine, exceeds greatly, in ratio of accelerated advance, that derived from the forest.

Classification of the iron according to the species of *fuel* used in the production of pig iron or cast metal, and in the fabrication of wrought iron, bar iron, &c. in France.

Years.	Pig or Cast Iron produced in Tons, omitting fractions.			Wrought Iron fabricated in Tons, omitting fractions.		
	With coal or coke only, or mixed with charcoal.	With vegetable combustible, wood or charcoal only.	Total Iron produced in Tons.	Exclusively, by means of coal.	By the partial or exclusive use of wood charcoal.	Total fabricated in Tons.
1819	2,000	110,500	112,500	1,000	73,200	74,200
1825	4,400	194,100	198,500	41,000	102,500	143,500
1830	27,100	239,200	266,300	46,800	101,600	148,400
1835	48,300	246,400	294,700	101,400	108,100	209,500
1840	77,000	270,700	347,700	134,000	103,300	237,300
1842	102,200	297,200	399,400	175,000	109,800	284,800
1844	146,600	280,500	427,100	206,500	108,500	315,000
1845	174,100	264,800	438,900	233,700	108,500	342,200

Supply of Fuel for the Iron works of France.

The iron made from coal in France is, in general, of an inferior quality; totally unfitted for railway and other engineering works. So fearful is the government of the entire deforesting of the kingdom, if charcoal iron works are carried on to any extent, that the amount to which they have raised the prices of forest-wood nearly amounts to an entire prohibition. France is, therefore, of necessity compelled to import iron from Sweden, Great Britain, Belgium, &c.

Prepared fuel.—The *Toulonnais* mentions certain experiments of great interest lately going on at the arsenal of Toulon, and which will lead to a great saving to the government. M. Grandjeau de Fouchy, captain of a corvette, by a discovery of his own, has been transferring coal-dust, of no use whatever, into blocks of coal. The ton of coal prepared in this way, will

* Compte rendu des travaux, 1846, Tab. 17, 190.

only cost nine francs, whilst we are paying twenty-two francs for that from England.*

Gas, employed instead of Fuel in the Iron works of France.

In the departments of the Meuse and Montblainville, gas is now used for puddling, from a refining furnace, heated with charcoal and a mixture of dry wood. The heating of steam boilers by gas is now generally adopted in nearly all the departments throughout France, and is a great saving of fuel.†

In 1843 there were eighty-nine steam engines, amounting to 2169 horse power, worked by gas from the metallurgic furnaces in France.

In Germany, the employment of gas in the high furnaces for refining of iron, has been decided in a perfectly satisfactory manner, at the forges of Treverai. It is only, however, practicable in certain cases; and it is, consequently, necessary that they must be near a high furnace of a sufficient propelling power, [either steam or hydraulic,] to carry out the twisting and drawing of the iron. This improvement has been latterly adopted throughout Germany and Sweden.

In the United States of America, there has been lately introduced the economic employment of the gases from the furnaces to the reheating and to working the blast, according to the process successfully adopted in Belgium and in France.

Epitome of Iron making in France, from 1843 *to* 1846.‡

Number of establishments, &c., exclusive of mining.	1843.	1845.	1838.
High furnaces, active and inactive,	597	615	558
Hearths, fineries, puddling furnaces, &c., for the fabrication of the iron,	2,132	2,322	
Forges, &c., for the fabrication of steel,	183	282	
Foundries and forges,	1,049	944	
Number of workmen employed in the production of the iron,	17,381	17,962	17,048
Workmen employed in making the forges, works, &c., and in the extraction and preparation of the minerals, 50,000 } 500,000	32,354	101,000	
Steam engines, number,	186	207	
Steam engines, horse power,	4,830	6,519	
Hydraulic wheels, mills or machines, number,	2,427	2,047	
Hydraulic wheels, mills or machines, horse power,	20,367	19,985	
Amount of cast metal and pig produced, in tons,	416,377	438,900	347,000
Amount of iron converted, bars, &c., tons,	304,000	342,200	
Number of iron mines worked in 1845, = 425,		425	
Value of the iron produced, in francs		121,365,437	
Value of the iron produced, in £ sterling,		5,056,893	
Value of the combustibles employed in the fabrication and principal elaboration of the foundry, of iron and steel, in 1845, in francs,		59,137,973	
Value of the combustibles employed in the fabrication and principal elaboration of the foundry, of iron and steel, in 1845, in £ sterling,		2,464,000	

At the commencement of 1847 there were from thirty to forty furnaces, for the working of iron, in the process of erection.

Argillaceous Iron ore in the Coal basins of France.

M. Elie de Beaumont, in his "Description of the Geological Map of France," remarks that "the carbonate of iron of the coal measures, so pre-

* Mining Journal, Nov. 2, 1844. † Ibid. Sept. 27, 1845; and March 7, 1846.
‡ Compte Rendu des Travaux, 1843–1846.

cious when it exists in sufficient abundance, is distributed in the coal formations of France with much irregularity; and indeed is very rare in that country. The basin of Aveyron is the only one which contains beds of it sufficiently powerful to supply high furnaces. It here occurs in rognons, kidneys or balls, disseminated in the schists which adjoin the coal beds, and sometimes even in the middle of the coal itself. That ore which occurs stratified is regular, and can be worked more advantageously than the kidney-shaped masses. It forms a bed overlying the great coal seam.

In the rich basin of Saint Etiénne, the iron ore is concealed or absent at some points; but the two beds which are worked, the only ones known in this locality, are thin, and produce not very rich ores. The great coal deposits of Valenciennes, Alais, Autun, and Creusot, are almost entirely deprived of beds of iron ore."

Iron.

Annual consumption of iron*—	1818	122,000 tons
	1824	175,000 "
	1845	480,000 "

Balance of ORES of IRON mined, imported to, and consumed in France.†

Produced.	Tons. 1845.	Employed.	Tons.
Indigenous ores extracted,	1,249,500	Ores consumed at the foundries,	1,259,300
Foreign ores imported,	10,300	Exported,	500
	1,259,800		1,259,800

It has been calculated that between the years 1815 and 1846, the iron masters of France have, by means of their monopoly, exacted from the consumers there, no less a sum than two thousand millions of francs, equal to eighty millions of pounds sterling, above what would have been paid for iron with a free trade, or even with a moderate tariff.‡

The condition of the iron establishments in 1838 was as follows:

	Active.	Inactive.	Total.		Total.
High furnaces,	98	41	139	For bars,	67
Foundries,			47	Martinets, hammers,	38
Fineries,			17	Platineries, plates,	32
Affineries,	220	36	256	Fenderies, for cutting bar iron,	26
Forge hammers,			131		

The quantity of pig iron produced in Belgium in 1839 was 90,000 tons; in 1842, 121,000 tons; in 1845, 150,000 tons.

Manufacture of Iron.

The following table exhibits the annual make of pig or cast iron [exclusive of steel,] and of converted or wrought iron, chiefly bars, made therefrom, in France; together with the number of high furnaces.

It has been estimated that to complete the system of railroads projected, France will, for several years to come, require 250,000 tons of iron annually. To meet this demand, it is thought that the iron masters, after supplying the ordinary wants of her population, will not be able to furnish more than 100,000 tons per annum.

* From Scrivenor's History of the Iron Trade, and from the Official Returns of France.
† Compte Rendu des Travaux, 1845–6.
‡ Paris correspondent of the Mining Journal, 19th Sept. 1846.

Years.	Pig iron. Tons.	Converted or malleable iron excl. of steel.	Number of high furnaces.	Years.	Pig iron. Tons.	Converted or malleable iron excl. of steel.	Number of high furnaces.
1819	112,000	74,000		1838	347,770	224,190	465
1824	194,670	139,730		1839	350,170	231,760	478
1826	202,750	143,330		1840	347,770	237,370	426
1828	210,000	150,000	393	1841	377,140	263,740	468
1834	269,060	177,160	409	1842	399,450	284,820	469
1835	294,800	209,539	438	1843	416,377	304,000	597
1836	303,739	201,690	444	1844	421,380		
1837	331,679	224,610	467	1845	448,900	342,000	594

Hence it is obvious that the production is vastly inadequate to the demand, and that even with a greatly increased ratio of production, France must, for a very long period to come, look to other countries to make up the deficiency. What prospect there may be for a speedy supply, by means of importation, to meet these extensive demands, will appear from the following table.

Iron Imported into France—Custom House returns.

Years.	Pig iron. Tons.	Wrought or bar iron.	Total. Tons.
1788	886	14,868	
1821			10,500
1827	7,790	7,130	14,930
1841	26,933	6,070	33,004
1842	32,980	6,970	39,950
1843	42,200	9,580	51,780
1844	53,110	7,160	60,270
1845	55,640	6,980	62,620
1847	85,000		

Statement of the annual Production of Pig Iron in Great Britain.

	Tons.	Tons.	Tons.	Tons.
	1841.	1842.	1844.	1846.
England and Wales,	1,116,630	1,152,790		1,330,000
Scotland,	270,920	195,000		884,000
Total,	1,387,550	1,347,790	1,575,260	2,214,000

Exportation of Pig and Wrought Iron from England to various countries.

Year.	Tons.
Av. from 1815 to 1835	100,000
1837	206,600
1838	271,000
1840	284,000
1842	381,000
1843	460,000
1845	351,620

But it has been calculated that for the requirements of the various railroads sanctioned by Parliament in Great Britain, that country would need in the three years 1846–7–8, an extra demand of between 200,000 and 300,000 tons, and apparently even much more. It is obvious, therefore, that France cannot expect much aid from England in the supply of railroad iron.

Railroads.

The attention of the government has been lately directed to the introduction of a complete system of railroads in France, in order to facilitate the transportation of coal, minerals and produce, besides merchandize and passengers, throughout every important portion of that country.

Those which were commenced, or were about to be commenced, in 1845,

amounted in length to	2821	kilometres,	= 1750	English	miles,
Previously completed,	2000	"	" 1241	"	"
Others proposed,	1417	"	" 883	"	"
	6238	"	" 3874	"	"

This entire series, it was then estimated, would be completed about the year 1851, at a cost of 1,540,000,000 francs, = £61,600,000 sterling, or 297,220,000 dollars. U. S.

The Railroad Map of M. I. Andriveau, Goujon, exhibits the following state of the national works in 1844–5:

23 completed,
6 in progress of execution,
5 lines authorized in 1842,
9 " " " 1844,

besides many others in contemplation.*

These comprise the great public routes, and do not include any of the lateral railroads in the vicinity of the coal and iron mines.

To complete these works the quantity of iron required was estimated at 3,000,000 tons. Extensive as is the range of these improvements in France, it fell vastly short of those projected in Great Britain, in the year 1845. Between the 1st of January and the 15th October, 1845, the railroad projects brought before the English public, embraced capital to the following amount:

Home undertakings,	£612,262,200
Foreign schemes with English capital,	79,250,000
Total,	£691,512,200

A very large proportion of these were subsequently abandoned, or never received the sanction of Parliament. The English railroads authorized to be made during the sessions of 1844–5 and 6, embraced a capital of £194,983,767, = $943,800,000.

Statistics of French Railways, October, 1846.†

	English miles.	Estimated cost.
Lines in operation,	523	£12,152,000
In partial operation, and shortly to be in operation,	1,024	20,980,000
Constructing,	958	21,720,000
Conceded and authorized to be conceded,	1,336	29,040,000
Not yet authorized,	323	6,116,000
Equal to $435,500,000, U. S. Total,	4,164	£90,008,000
Estimated average cost per mile, = $104,626,		£ 21,617

* Carte des Chemins de Fer de la France, 1844.
† Journal des Chemins de Fer.

Steam power in France.

Statement of the number and capacity of steam engines for mining, manufacturing and other industrial purposes, as also for commercial steam vessels, in France; derived from the "Compte rendu des travaux des Ingénieurs des Mines," and other official sources.

Years.	Classification and details.	Number.	Steam horse-power of 3 draught horses each.	Horse-power of 7 men's power each.	Men power.
1837	Steam engines employed for industrial uses, - - - - -	1,842	24,144		
	Commercial steam vessels, -	124			
	Engines employed, - -	150	5,408		
	Passengers conveyed, - -	2,190,621			
1838	Steam engines, industrial, -	2,077	27,677		
	Locomotive engines, - -	48	1,225		
	Mercantile steam vessels, number,	160			
	Engines to do. - -	207	7,493		
	Passengers conveyed in do. -	1,418,189			
1839	Steam engines, industrial, on land,	2,450	33,308		
	Establishments employing them, -	3,257			
	Mercantile steam vessels, number,	225			
	Engines therein, - - -	300	11,297		
	Passengers conveyed in do. -	1,969,905			
1840	Steam engines, industrial, -	2,591	34,350		
	Establishments, - -	3,290			
	Mercantile steam vessels, number,	211			
	Engines therein, - -	263	11,422		
	Passengers conveyed in do. -	2,547,116			
	Aggregate of moving power, -			143,706	1,005,942
1841	Steam engines, industrial, - -	2,810	37,304		
	Establishments, - -	3,503			
	Mercantile steam vessels, - -	227			
	Engines therein, - -	291	11,856		
	Passengers conveyed in do. -	2,426,637			
	Aggregate of moving forces, -			155,085	1,085,595
1843	Steam engines, industrial, -	3,053	39,009		
	Establishments, - -	3,871			
	Steam vessels, - - -	242			
	Engines employed, - -	392	12,748		
	Aggregate of moving forces, -			177,306	1,241,142
	Passengers conveyed in the steam vessels,	2,591,965			
1844	Steam engines, industrial, -	3,645	45,780		
	Establishments, - -	4,234			
	Locomotives, - - -	292			
	Steam vessels, - -	238			
	Engines employed, - -	382	12,789		
	Aggregate of motive power, -			188,847	1,321,929
	Passengers conveyed in the steam vessels,	3,286,579			
1845	Steam engines, industrial, -	4,114	50,188		
	Establishments, - -	4,532			
	Locomotives, average 45 horses, -	313			
	Commercial steam vessels, -	259			
	Engines, - - - - -	446			
	Weight of merchandize and passengers transported, tons, - -	938,959			
	Aggregate of motive power, -			218,799	1,531,593
	Number of passengers conveyed by steamboats, - - -	3,461,336			

Average number of horse power to each engine.

	1840. Horse power.	1844. Horse power.	1845. Horse power.
Industrial, High pressure engines,	39.77	37.68	44.50
Industrial, Low pressure engines,			39.00
Locomotive, high pressure,		25.50	45.00
Steam vessels, mercantile	13.02	10.04	12.14

The steam marine of the French navy, not included in the previous tables, amounts, for the year 1847, to 66 vessels of 14,570 horse power.

Large as the amount of steam power in France appears, it represents scarcely one twelfth of the mechanical power employed in England. The national steam marine of France required for the year 1846, 120,000 tons of coal, and the mercantile marine, 236,000 tons, the greater part of which supply was drawn from England.

Provident Institutions—Caisses de secours—Caisses de prévoyance.—Of late years, following the example of Belgium, the government of France has extended its influence, under the report of the secretary of state for public works, and with the advice of the General Council of Mines, and the co-operation of the "concessionaries," to found institutions of this benevolent and useful character, in those departments where a mining population is most concentrated, and would greatly profit by their salutary influence.

We have devoted a preliminary chapter to this subject, and refer the reader thereto.


Basin of the Rhur
Dusseldorf
Cologne
Bonn
Rhine R.
Meuse R.
Roldac
GIUM
Liege
Eschweiler
RHENISH PRUSSIA
Coblentz
Frankfort
Maine R.
Mayence
Moselle R.
Basin of Saarbruck
RHENISH BAVARIA
Luxemburg
Manheim
Necker R.
St. Imbert
Forbach
La Nied
Moselle
Lobsann
GRAND DUCHE OF BADE
Meuse
Meurthe
B. Rhin
Finist
Norroy

KINGDOM OF BELGIUM.

Entire area of land, 2,942,574 hectares=7,271,100 English acres; area under cultivation, 2,220,000 hectares=5,185,620 English acres; ascertained area of coal land in 1838, one twenty-second of the whole, or 134,113 hectares=331,392 English acres; amount of fixed and provisional concessions for working coal, 123,765 hectares=305,820 English acres; area of ditto in 1843, one seventeenth for ditto, 166,649 hectares=411,787 English acres; in 1838, for working iron, 50,221 hectares=124,096 English acres.

Population, about two persons to each hectare, 4,242,600.

System of Weights, Measures and Currency.

Belgium has adopted the weights and measures of the French metrical system; the fundamental principle of which is the measure of length. Its unity, the *mètre*, is the ten millionth part of a quadrant of the meridional circle of the earth. The length of the metre is nearly an inch less than the English yard and half a quarter;—that is, 3 fr. 28 dec.

The unit of superficial measure, the *are*, is a square, of which the side is ten mètres.

The unit of the measure of capacity, the *litre*, is a cube, of which the side is the tenth part of a mètre,=61.028 cubic inches.

The *stère* is a cubic metre,=35,317 cubic feet.

The unit of the measure of weight is a *centimètre* cube of distilled water; that is a cube of which the side is a hundredth part of a metre.

The itinerary measures are the *decamètre*,=10 mètres; the *kilomètre*,= 1000 mètres; and the *myriamètre*,=10,000 mètres.

Land is measured by the *hectare*, containing 10,000 square *mètres;* the *decare* of 1000 square mètres, or 1196 square miles; the *arc*, containing 100 square miles; and the *centiare*, which is one square mile.

For solid measure, are used the *stère* and the *decistère;* that is, a cubic mètre and its tenth part.

For the measure of weight are used the *gramme*, the *decagramme*, or 10 grammes; the *kilogramme*, or 1000 grammes; and the *quintal*, or 100 kilogrammes.*

Table of Corresponding Measures, English, and Belgian or French.

Belgian.	English.	Belgian.	English.
Metre,	3.28 feet,=39.37 inches.	Hectare,	2.471 acres.=11.960 sq. yards.
Millimetre,	0 039 inch.	Litre,	1.760 pint,=61.03 cubic inches.
Centimetre,	0.393 inch.	Decalitre,	2 201 gallon,=610.28 cub. inches.
Decimetre,	3 937 inches.	Hectalitre,	22 009 gall =284 W. bushels.
Myriametre,	6.213 miles,=10,936 yards.	Gramme,	15.434 gr troy.
Metre Carre,	1 196 square yards.	Kilogramme,	2 680 lbs. troy,=2lb. 8oz. 3dwt
Are,	0.098 sq. rood,=119.6 sq. yards.		2.605 lbs. avoir =2lb. 3oz. 4dwt
Decare,	1196 0 square yards.	Millier or Bar,	9 tons, 16 cwt. 3 qrs. 12 lb.

* Chiefl y derived from McCulloch's Gazetteer, and Loudon's Tables.

The Belgian kintal,=103 lbs. English,=47 French kilometres.
21 Belgian kintals,=75 lbs.=1 ton English,=2240 lbs.
10,1465 metrical quintals=1 do. do.
The hectolitre, used in coal measure { 90 kilog.,=284 Winchest'r bushels. 3½ cubic feet,=22 imperial gallons.
11.26 hectolitres,=1 ton English.
1014.65 kilogrammes,=1 ton, in ordinary calculations, 1000 kilogrammes are held as 1 ton.
1 hectare of land,=2.471 acres English.
1 vierkantebunder,=119.6 English yards square,=1 French acre.
1 metrical mile,=1093 English yards,=1 French kilomètre.
1 mudde,=6102 cubic inches English,=2,837 bushels,=100 French litres.

Currency.

The franc is the monetary unit of Belgium, and its divisions are made according to the decimal system.
1 franc,=9.69 pence English,=0.19⅜ U. S. currency.
20 francs,=1 napoleon,=1 new louis,=16*s.* 2*d.* English,=$3.86 U. S.
1 English sovereign in Belgic money,=25 francs, 20 centimes.
1 English shilling,=1 franc, 16 cent.

Discovery of Coal, and Progress of Mining Enterprise.

The discovery of bituminous coal in Belgium, as is stated by the local historians, was first made, in the country of Liege, by a blacksmith, named *Hullos de Plennevaux*. This occurred A. D. 1198 or 1200, and hence is said to have originated the new common name of the mineral carbon, *Houille*. It is only a few years ago, that, opposite to the entrance of the collegiate church of St. Martin, they yet showed the place where the first opening on the coal was made.

The coal mines of Belgium, like those of France, have, from a very early period, been subjected to the inspection of government officers. This system, notwithstanding its seeming interference with the exercise of private rights, and with the management of individual property, has much to recommend it; and, in fact, has been strongly urged to be put in practice in Great Britain, whose coal mines, so vital to her strength and prosperity, it seems surprising should so long have been left entirely to the unassisted efforts of individuals, without organization or even the supervision of the State.

So early as the fifteenth century—A. D. 1487—the Prince Bishop of Liege issued a commission on mines; which commission found that there had been established, from the most remote times, a court or jury of four persons, afterwards increased to seven, called "*La cour des voir jurés du Charbonnage*," for the investigation and direction of the affairs of mines; and that two of its members were obliged to descend, periodically, [every fifteen days] to examine them.

King Philip, in 1635, passed an ordinance touching the coal mines of Namur, and Charles of Spain, as Duke of Limbourg, in 1694, issued an edict of fifty-six articles, on the coal mines of that duchy. During our own times, France, the Netherlands, and Belgium, have distinguished themselves by issuing laws for the regulation of the working of their respective mines; leaving England the very last in the field to establish a system of such important, humane, and necessary judicial interference.*

* Articles on the causes and means of prevention of accidents in coal mines, in the Mining Journal of London, March 4th and August 5th, 1843.

In Spain, where the business of coal mining is as yet in its infancy, the importance of carrying on the colliery workings agreeably to the mining laws that are already in force as regards all other minerals, has recently become the subject of application to the government from the coal proprietors of Asturias. They complain that "at present, the peasants, without any subjection to the rules of art, or to the payment of dues, raise up the coals by means of pits, sixty or more Spanish yards deep; and, as they have nothing to disburse for scientific direction, and incur none of the other expenses which fall upon the regular companies, they prevent the proper development of this new source of industry. All we want, therefore, is the strict observance of the laws, and special protection from the government."*

Area of Coal-fields in Belgium.

This country is traversed in a direction from nearly west south-west to east north-east, by a large zone of bituminous coal formation. The statistical divisions of this band have not been uniformly adopted or described by local topographers, and some confusion has occasionally taken place among authors, from this circumstance. We shall, therefore, as far as practicable, adhere, in the following notes, to the arrangement ordinarily observed in the official reports made to the Belgian government; at the same time shall avail ourselves, wherever it may be desirable, of the statistical details which have occasionally been furnished by cotemporary authorities.

The entire region has been customarily described under two principal divisions, as follows:†

The Western or Hainault Division—Comprises

1. { A. The two basins known as the Levant and the Couchant of Mons.
   B. That of Charleroi.
2. That of Namur.

The latter lies within the province of Namur; while the two former are within the province of Hainault; stretching into the department du Nord, in France, where its traces are lost, a little below Douay.

The Eastern or Liege Division.

Commencing in the province of Namur, and embracing a small portion thereof, traverses the province of Liege; directing itself towards Rhenish Prussia, where it communicates with the coal basins of Eschweiler and Rolduc, and with the Duchy of Limburg, in the Low Countries. The point of division between this and the preceding is said to be the deep and narrow gorge, through which the Sampson river flows, in the province of Namur. The whole belt is about a hundred miles in length; or, including its prolongation into France, one hundred and fifty miles.

As the government returns are made, not according to any supposed geological divisions, but with reference to the provincial areas, the latter will be represented as below:

According to Provinces.

	Length in miles.	Area in square miles.	Area in hectares.	Area in English acres.
I. In the province of Hainault,	39	274	75,725	187,116
II. In that of Namur,	24	59¼	16,643	41,125
III. In that of Liege,	33	151¼	41,745	103,151
Being the 1-22d part of the superficial area of Belgium,	96	485	134,113	331,392

* Address of the *Espada* Colliery Company of Oviedo, to the Central Mining Junta of Carthagena. † Bulletin de la Commission Centrale de Statistique de Belgique, 1844.

The subdivision of this great Belgian coal zone is as follows:

According to Geological Areas.

COAL BASINS.		Length in English miles.		Area in square miles.	Area in hectares.	Area in English acres.
Western, or Hainault,	I. In the province of Hainault, 75,725=187,116 acres.	39	57	= 325	= 90,051	= 222,516
	II. In that of Namur 14,326,=35,490 acres.	18				
Eastern, or Liege Division,	II. In the province of Namur, 2,317,=5,725 acres.	6	39	= 160	= 44,062	= 108,876
	III. In that of Liege, 44,745,=103,151 acres.	33				
Total, according to the official report in 1842.*			96	= 485	= 134,113	= 331,392

There appears to be a discrepancy between these estimated areas, and the official aggregate of "Concessions," or grants to work the coal beds within the Belgian region. The difference is explainable on the one hand, on the probable ground that the concessions frequently occupy more area than strictly belongs to the coal formation; and, on the other, that the entire mineral areas are not yet conceded. We annex the returns of those grants of mining lands.

According to Concessions, Fixed and Assumed, or Conditional, in 1844.

	Hectares.	English acres.
First Division—Hainault, Tournay, &c.,	87,550	216,336
Second Division—Namur and Luxembourg,	12,157	30,040
Third Division—Liege and Limbourg,	29,721	73,440
Total,	129,428	319,816

It will be necessary to bear in mind, with reference to these areas, that one series represents the superficies of the geological basins, while the other is that of the lands both conceded and provisionally granted. The coal-field of Belgium is said to be superior to any on the Continent of Europe, and is estimated to be more valuable than the silver mines of Peru, or the gold of Brazil. The basin of Mons contains above *one hundred and thirty* coal seams, disposed one above the other; all workable and all wrought. The four principal collieries of Mons, Marimont, Liege, and Charleroi, yielded, in 1838, 3,260,271 English tons, and 4,500,000 tons in 1844.

One of the richest deposits of coal that is known forms the nearly continuous series of coal basins placed along a belt one hundred and fifty miles long, and from six to ten miles broad, which, passing through Belgium, crosses the north of France, and contains the collieries of Valenciennes, Condé, Mons, &c. At Liege, the measures are said to comprise eighty-three beds, and at Mons there are no less than *one hundred and fifty* coal seams.

These coal basins produce, at the present time, an annual amount of four and a half millions, or more, of tons of coal; worth fifty millions of francs, and employ more than forty thousand colliers.

The Belgian coal formation is of the same geological horizon with the great coal-fields of England. It is remarkable for the undulating character of the beds of coal. Through a great part of its south-eastern boundary it

* Rapport présenté au Roi. Statistique de la Belgique, 1842—the latest official return.

is *inverted, so as apparently to dip under the older formations;* but on a portion of its northern margin, the earlier formations emerge in their regular order.*

In one respect, the southern coal-fields of Belgium differ from those of other countries, especially of Scotland and Wales. This is in the comparative absence of seams of iron ore. A contributor to the London Mining Journal asserts that coals and iron are no where to be found together in Belgium.

We proceed to notice the principal coal statistics of this country. In Belgium the coal business has felt the influence of political changes. From 1802 to 1832, instead of increasing, it experienced some small diminution in the annual amount of production. Latterly this was, no doubt, owing to the loss of the exclusive supply to Holland, with which this country had been previously united. From 1832 it considerably increased, being now probably about double the production of that year; owing to the vast amount of additional capital brought by new companies into the trade; we will briefly trace the progress of Belgian mining industry.

In 1826, there were above two hundred and forty mines in work; all very rich, and giving employment to several thousand persons.

In 1839, there were 166 fixed, and 136 provisional concessions; comprising 483 pits or places of extraction in activity, employing 29,693 miners and 394 steam engines, of the aggregate power of, 17,553 horses. These forces raised 3,479,160 tons of coal, whose value, at the pit's mouth, was returned at £1,823,745 sterling, or $8,708,852, U. S. currency, or 45,123,595 francs.†

In 1843, the three coal districts comprised 411,787 acres of coal land, held under concession from the crown, by different companies, and the mining operations were greatly extended; producing, it is stated, nearly four millions of tons. It was officially announced, in this year, that the capital embarked by different associations in coal and iron establishments, was 40,540,000 francs, or £1,637,318 sterling = $7.836.400.

In 1844 there were 307 coal concessions in Belgium, of which 108 were provisional merely; 224 of these were the property of companies, and 83 belonged to anonymous associations. Their annual production was 4,445,-240 tons of coal; being more than half a million of tons greater than that of France, and one seventh part of that raised in Great Britain. She exported this year 1,300,000 tons.

The value of the coal produced this year was estimated at near forty millions of francs.‡

The production during the year 1845 has been announced by the engineer of mines at 4,960,077 tons; exceeding the indigenous production of France by 1,177,388 tons.

This is greater than was ever before known. The increase in the province of Liege was 25 per cent. and in Hainault 10 per cent. over 1844.

The result of a geological survey of the mineral resources of the Sambre and the Meuse, by Mr. Sopwith, in 1846, shows that the coal mines in that part of Belgium are capable of producing a quantity equal to one tenth of all the coal raised in Great Britain.

In order to combine in one view, the various statistical details of the Belgian coal trade, of which we have given the foregoing outlines, we arranged the whole in the following tabular statement.

* Sedgewick and Murchison in Geol. Trans., 1840.

† Bulletin de la Commission Statistique, 1843, and Compte rendu 1839, 1844.

‡ The value of the coal production of France, the same year, was thirty millions of francs; that of England, at the pits mouth, about 225 millions.

Statistical Table of the number of concessions, collieries, and pits in operation, their annual production in English tons, the average prices of coal at the pit's mouth, the number of miners employed, and the value of the produce at the mines, rendered in Belgian, French, American and English currencies; in the Provinces of Hainault, Namur, and Liege.

Years.	No. of Concessions fixed & conditional.	Pits in work or in construction	Miners.	Production in Tons.	Price per ton. fr. cts.	Value of Production at the Mines. Belgian and French francs.	American Dollars.	English £ Sterling.
1830	224	314	29,253	2,533,761	10.23	25,920,000	5,011,200	1,047,600
1832	224			2,249,000	7.54	16,957,500	3,278,445	684,659
1834	307	341	28,606	2,443,568	7.82	19,108,700	3,694,276	772,280
1836	307	471	29,144	3,056,464	10.95	30,533,922	5,801,447	1,221,300
1838	307	531	37,171	3,260,271	13.93	42,818,180	8,278,181	1,728,784
1840	307	660	38,502	4,000,000	13.85	55,400,000	10,692,200	2,209,132
1844	307	540	38,490	4,445,240		39,844,191	7,689,930	1,610,360
1845				4,960,077				

In point of rank, as a coal producing country, Belgium stands the second in Europe, and probably in the world; Great Britain being the first; France and the United States are about equal producers at the present moment, and Prussia is the fifth.

Table of the periodical prices of Belgian coals at the pit's mouth, and the canals; per English tons of 10,146 metrical quintals, in Belgian, American, and English currencies.

Divisions.	Years.	Quality.	Francs.	Dollars.	s. d.	Description.
I. Mons or Hainault division. 1st district.	1829	best coal	15.0	3.00	12 0	Flenu coals at the pit.
	1836	do	17.0	3.28	13 8	
	1837	do	19.0	3.66	15 4	
	1838	do	20.0	3.86	16 1	
	6 years to 1841	average quality	13.0	2.75	10 6	At the canals.
	1842	best	20 0	3.86	19 2	Pit's mouth.
	1844	best	20.0	3.86	19 2	
Charleroi or 2d district.	1829	best	18.0	3.47	14 6	Pit's mouth.
	1836	do	22.0	4.24	17 9	
	1837	do	23.0	4.43	19 0	
	1838	do	23.0	4.43	19 0	At the canals.
	1843	coking	7.0	1.35	5 6	Pit's mouth.
			10.0	1.93	8 0	
	1844	various	13.0	2.50	10 6	
			19.0	3.67	15 4	
II. Second or Division Namur and Luxembourg. 3d and 4th dist.	1838	large coals		4.52	18 8	At the canals.
	1840	coals of all kinds	6.12			
	1842		5.23			
	1844		5.10			
III. Liege Division 5th, 6th, and 7th districts.	1829	avg. of best	20.0	3.86	16 1	On the canals.
	1836	do	22.0	4.24	17 9	
	1838	do	25.0	4.82	20 0	
			28.5	5.50	23 0	
	1830	average	10.23	1.97	8 3	At the pit.
	1832	do	17.54	1.45	6 1	
	1834	do	7 84	1.51	6 4	
	1836	do	10.95	2.12	8 10	
	1838	do	13.95	2.70	11 3	

Exportation of Coal from Belgium to Foreign Countries.

The principal foreign markets for the coal of Belgium are, at present, France and Holland. Her government has made great efforts, of late, to

establish new channels for the sale and consumption of her mineral combustibles. The exportation to France has a little diminished between 1837 and 1840, and has subsequently much increased, while that towards Holland has steadily augmented.

Of the respective "debouches" or outlets for the transportation of this coal, we shall speak when detailing the separate statistics of the three principal mining districts.

Table of the *total exportation* of coal, chiefly to France; from the official records: in Belgian kilogrammes, 1014½ to each ton, and English tons.

Years.	Kilogrammes.	Tons.	
1829		867,840	
1830		621,560	
1831	471,614,528	465,100	
1833	583,523,091	575,450	
1834	660,013,705	650,900	
1835	702,203,891	692,500	
1836	782,904,021	772,100	
1837	800,649,729	789,600	
1838	786,974,866	776,100	Average value, 11,590,415 fr.
1839	756,438,612	746,000	
1840	788,748,505	777,850	
1841	1,022,955,500	1,008,220	
1842		1,014,715	Value, 15,220,731 fr.
1844		1,243,400	
1845		1,543,472	
1846		1,356,073	
1847	11 months,	1,695,000	

Belgian Importations of Coal, Coke, and Cinders.

Although a largely exporting country, Belgium receives on her frontier, and from occasional sources, a small supply of foreign coal. We derive the following details from the government returns. In regard to the imports from France, we quote the Belgian documents. Those of France generally represent the Belgian exports as greater, and the imports as less, than the Belgian returns.

We annex to this table a statement of the amount of foreign coals, annually forwarded through Belgium to various countries.

	Importations.			Commerce of Transit.	
Years.	Kilogrammes of 1014½ to 1 ton.	English Tons.	Imports from France. Tons.	Kilogrammes.	Tons.
1831		770		2,100,000	2,070
1833		7,979		3,731,000	3,680
1835	15,583,625	15,350	14,930	6,617,100	6,085
1836	22,447,807	22,230	21,450	9,292,505	9,164
1837	28,416,835	28,020	26,070	11,566,126	11,406
1838	34,705,271	34,220	28,910	11,440,321	11,282
1839	28,364,548	28,000	22,150		
1840	30,484,435	30,000	26,100		
1841	36,980,600	36,440	28,936		
1844			12,576		
1845		9,449	10,000		
1846		11,071			
1847	First 8 months,	14,050			

Detailed table of the Belgian Exportations of Coal.

Statement of the principal foreign countries to which this coal was exported from Belgium, according to the published official documents, in relation to special commerce. The official returns of France appear generally to exceed, in amount, those of Belgium, but we have not thought it necessary to quote them both, in this place. The recent returns show that the exportation of coal from Belgium to France is decreasing, while that from England is increasing.

Years.	To France.		To Holland.		To all other Countries.	
	Kilogrammes.	Engl. Tons.	Kilogrammes.	Tons.	Kilogr.	Tons.
1787		49,280				
1789	50,730,000	50,000				
1802	88,097,710	86,830				
1811		93,630				
1816	202,920,000	200,000				
1820		224,100				
1830		503,750				
1832		489,480				
1833		580,117				
1834		611,610				
1835	691,653,190	682,100	5,172,831	5,100	5,377,870	5,330
1836	770,433,285	759,750	7,288,101	7,190	5,182,635	5,160
1837	790,369,264	779,450	6,685,400	6,590	3,595,065	3,570
1838	774,784,089	764,050	7,248,686	7,150	4,942,091	4,910
1839	734,051,986	723,900	17,551,106	17,300	4,835,520	4,800
1840	723,732,681	713,750	60,757,444	59,910	4,258,380	4,190
1841	916,127,600	902,944		95,650		3,416
1842	915,889,566	902,710	102,697,000	102,697	*	9,308
1844	1,115,794,900	1,096,057				
1845		1,376,100				
1847	11 months,	1,345,000				

By the Belgian law of the 26th of August, 1822, the transit of coal arriving from one part of a neighbouring state and destined for another part of the same state, is only subjected to a duty of 40 centimes per 1000 kilogrammes. This is after the rate of .39 penny, or .78 cent per ton.

The quantity of coal which descended the Rhine from the German provinces, into the Netherlands at Lobith, was as follows:†

In the year 1841, 136,925 tons.
In the year 1802, 101,610 tons.

Import duties paid on English coal, per ton.

	s.	d.	
In 1778, import duty on British coal, into the Netherlands, was	10	0=	$2.42
In 1814, and continuing until 1834, - - - - -	2	9=	0.66
In 1840, to 1st April, 1842, 14 frs. and 84 cts. per 1000 kilog.	11	8=	2.76
In 1842, 30th June, removed altogether,	free		
In 1847, the duties are again very high.			

* Tableau général du commerce de la Belgique avec les pays étrangers.
† Documens sur le cemmerce extérieur, Janvier, 1844.

Import duty paid by France.

In 1840, 3 fr. 30 cts. per 1000 kilogrammes, 2*s.* 6*d.*=$0.60.

Being a producer of coal on an enormous scale, the imports of that combustible into Belgium is of small amount. Until lately, the tariff of import duty on coals was greatly in favor of France.

There are no *export duties* on coal in Belgium, except a small one to Holland.*

For the list of duties imposed by France on Belgian coal, at various periods, see under the head of France. Mons coal has risen in price since 1838, and the Belgian government has, consequently, acceded to the wishes of the home consumers, and of the British producers, to receive from 1839, coals free of duty. By France a similar mutual boon has been granted; and the Belgian and French manufacturers are overjoyed at the concession.†

Export duty on coals passing from Belgium, by *canals and rivers.*—The law of the 30th June, 1842, was extended. By this law Belgian coals passing to Holland, either by sea or by internal communication, were reduced seventy-five per cent. on the duty then paid ‡

The treaty between Belgium and the German Zollverein, 16th October, 1844, does not appear to affect the transit of coal. The reduced duty paid by Belgian coals, on entering France, is about 2*s.* 6*d.* per ton.

Comprehensive general Statistical Table of the Production, Exports, Imports and Consumption of Coals within the Kingdom of Belgium.

This table is prepared from official documents, and from some other sources.

No 1. Years.	No. 2. Production at the mines Tons.	No. 3. Imported. Tons.	No. 4. Exported. Tons.	No. 5 Consumption on the spot. Tons.	No. 6. Total of consumption in Belgium. Tons.
1802	2,635,000				
1830	2,533,761		621,560	250,000	2,162,000
1831	2,270,000	770	468,000	227,000	2,029,000
1832	2,249,000	5,790	1,287,000	224,000	1,191,790
1833	2,708,000	7,979	576,000	270,800	2,404,000
1834	2,747,000	10,915	654,000	274,000	2,378,000
1835	2,902,000	8,840	685,000	290,000	2,516,000
1836	3,056,464	12,830	761,000	314,000	2,622,294
1837	3,230,806	16,675	789,083	323,000	2,784,398
1838	3,260,271	22,034	775,000	326,000	2,838,332
1839	2,812,256	28,678	746,000	281,000	2,840,934
1840	3,170,000	40,930	777,850	300,000	2,670,080
1841		36,440	1,015,194		
1842	4,141,463		1,014,715		
1844	4,445,240	12,560			
1845	4,960,077	19,449			
1846			1,350,000		
1817	First 11months,		1,695,029		

Respecting this schedule, we have to premise that most of the details in columns No. 3 and 4, representing the importations and exportations, are

* Documens sur le commerce extérieur, Paris, May, 1843.
† Belgique Législation commerciale, Janvier, 1844.
‡ "Arts and Artisans, at home and abroad," Jellinger Symons.

those which commonly appear in the English statistical tables. In the preceding tables will be found the exact Belgian returns, accurately rendered into English tons from French kilogrammes of 10.1465 to the ton. The 2d column, representing the production, is reduced from metrical quintals of 10.146 to one English ton. The 5th column is that of the consumption on the spot, estimated at one tenth and not included in column 2.

Notwithstanding that Great Britain has the advantage of all other countries in the world, in having her coal, for the greater part, close to her seaports, yet her greatest European rival, in supplying the continental markets, is Belgium. The latter also has a competitor in Prussia, whose Rhenish provinces furnish extensive supplies to Germany and France. In both cases, the expenses of mining or bringing the coal to bank, is fully as cheap as in England.

But if, as appears more than probable, from the report of Mons. Briavionne, the engineer in chief of the Belgian coal mines, all the coal which it is practicable to mine to advantage, in western Belgium, will be exhausted before twenty years, it is obvious that it cannot be the policy of that country to continue an exporting one; at least after a few years from this time.

We proceed to give a brief sketch of the separate coal districts which have been previously enumerated.

The administrative arrangement of the coal mining departments of Belgium, into three divisions and seven districts, as organized, 29th August, 1831, and as recapitulated in the recently published reports, which include the period between 1839 and 1845, may, with some propriety, be stated here.

First division.—Province of Hainault.

1st district, Judiciary arrondissements of Mons and Tournay.
2d district, " " Charleroy.

Second division.—Provinces of Namur and Luxembourg.

3d district, Province of Namur.
4th district, " Luxembourg.

Third division.—Provinces of Liege and Limbourg.

5th district, parts of these provinces on the left bank of the Meuse.
6th district, " " " right bank of the Meuse.
7th district, Judiciary arrondissement of Huy.

FIRST DIVISION—FIRST DISTRICT.

Basin of the Sambre or Hainault, in the western division, and in the provinces of Hainault and Namur. Within these provinces, and forming the *western coal division* of Belgium, are comprised three important coal basins, which are occasionally classed under the general denomination of the Basin of the Sambre.

First Division, Province of Hainault.	A. These are the basins of Mons.	Arrondisements of Mons and Tournay.
	B. do. of Charleroy,	Arrond't of Charleroy.

Coal Basin of Hainault, extends in that province thirteen leagues in length by a mean breadth of two and a half leagues; occupying thirty-one and a half square leagues. It is covered by 106 communes, and 154 concessions, occupying a surface of 83,290 hectares,=205,817 English acres, the population of which, in 1806 was 133,963 souls, and on the first of January, 1841, was 211,717 persons; being an increase of fifty-eight per cent.

This is a population of 6829 persons to every square league, and therefore is remarkable for its density.*

In Namur this coal district covers 16,643 hectares more.

In the province of Hainault we meet with all varieties of coal, from the most meagre, called by some authors *anthracite*, to the fattest coals, proper for the fabrication of coke; including the flaming species locally called *flenu*, approaching to that of Newcastle in England, and sought after for its evaporative purposes.†

The annual amount of coal extracted from the basins of Hainault and Namur alone exceeds the whole production of France.

We have shown the annual returns from the Hainault district, comprising the Mons and Charleroy basins in a previous table. These show the progressive increase in the quantity of coals raised, from 2,349,374 tons in 1836, to 3,671,023 tons in 1845. The number of pits in activity and construction increased from 274 in 1829, to 441 in 1838; in 1844 employing 378 steam engines, of an aggregate power of 16,752 horses, and 27,719 working miners. Coal raised in 1829=1,761,118 tons; in 1845, 3,671,-023 tons.

Mons District, [A.]—Basins or sub-basins of the Levant and Couchant, of Mons in the province of Hainault, arrondissements of Mons and Tournay.

In 1840 these comprised 69 concessions, underlying 52,607 hectares, or 129,931 English acres. The local statistics of the mines are as follows:

Numbers of coal pits in activity and in construction, 87 in 1834, increasing annually to 178 in 1838. Average depth of pits in 1838, 690 feet. Number of working miners, 16,896. Quantity of coal raised in 1829, 2,361,965 tons; in 1839, 1,691,550 tons.

The coals from the Mons district go to Brussels by the Charleroi canal.

In 1843, 7363 boats were loaded on the canal de Condé, with	1,120,184 Engl. tons.	
In 1844, 7898 do.: 5172 boats despatched for Paris & intermediate parts, 734,014 tons; 2726 do. to Flanders, Antwerp, Brussels, &c., 503,916 tons.	1,237,930‡	"

In this district are 114 coal beds, among which the group *Flenu*, containing fifty-two seams, is the richest. In point both of quality and quantity, the most remarkable deposit of coal is almost entirely situated in the "*Couchant de Mons*," which here forms a band 6⅛ miles deep.

The varieties of the coal of the Mons district are sufficiently numerous and important to require classification, which is generally done under three distinct heads. These are,

1st. The coal called *Flenu Coal*, from the locality in which it was first mined. This species burns rapidly, with much flame and smoke; does not produce a very intense heat, during combustion; and gives out, commonly, a disagreeable odour in burning. The coke produced from it is too friable to be advantageously employed in the foundries. Fracture fibrous, rhomboidal; sonorous almost as charcoal. Fifty-six seams of this coal occur near Mons. Mr. Dunn says that the quality of the Flenu coal is unlike anything in England, but is very similar to that of Swansea in South Wales; viz: a species of conglomerate, without hardness, or without those facings which characterize the coking coal of England.

* Rapport sur la situation du Hainault, 1842, p. 30.

† Rapport au Roi,—Mines, Usines, Minéralurgiques, Machines à Vapeur, 1842.

‡ Commerce extérieur de la Belgique, Dévelopement du Commerce Belgique.

2d. *The Fat Coal.*—Divides readily in small cubes; is more friable than the Flenu; gives less of flame and smoke, but produces a more intense heat. It is eminently proper for the forge; for the fabrication of coke; for the foundries, and for heating rooms; because it gives little or no smell, and burns slowly; swelling in the burning. This quality comprises two series of seams; the highest, called "glassy coals," contain twelve beds: the lower, comprising twenty-nine beds, called "large coals."

3d. *The meagre, lean, or dry Coal and Anthracite:* has the same fracture as the fat coal; is still more friable, and does not coke in the fire, because it contains not sufficient bitumen; for which reason it will not make a good coke, and cannot be employed, except for gas lighting. It is chiefly fit for the burning of bricks and lime. Not possessing any cementing quality, it does not obstruct the currents of air in the brick kilns or lime kilns, but burns very slowly and gives out a regular, equal heat. Thirty-four seams of this quality occur to the westward of Mons.

These three varieties of coal do not abruptly pass from one to the other; but merge insensibly into those gradations. The beds which are the type of the quality called *Flenu coal*, are first in the order of super-position. They acquire the quality of *fat coal* as they approach the lower part of the basin; in the same degree as the fat coals pass to the quality of *thin or dry coals*, of which the type is in the last beds of the bottom.

It is on record, that in the basin of Mons there are no less than one hundred fourteen seams of coal; all workable. A transverse section of this vast series, occurring in the mines of the neighbourhood of Grand Hornu, was republished by Mr. Dunn, in 1844.

An authority of yet later date, announces a still more discriminating arrangement than the foregoing. In the following statement is specified the several beds and qualities of coal, in the Mons basin, in the order in which they successively occur, from the exterior to the centre of the basin.

13 beds of *dry coal*, good for burning bricks and lime.

23 beds or seams of "*charbon de fine forge*," quality not pyritous; yielding sixty-five to sixty-eight per cent. of good coke. These seams are not all workable; and, in quality are considered inferior, for forge purposes, to the coal of Saint-Etienne, in France.

29 beds of "*hard coal*;" bituminous, caking; giving a fine coke; used in foundries and high furnaces, and contains very little pyrites.

49 seams of "*Flenu coal.*" This has given a high reputation to the basin of Mons, and forms the greater part of its "*exploitations.*" It is a brilliant coal; not readily reduced to powder; eminently easy of ignition; burning with a long and bright flame. In a word, it is the coal, of all others, for steam boilers.

114 beds in all; which, in general, vary from eighteen inches to two feet nine inches in thickness; but some of them are upwards of six feet in thickness and of much regularity.

The workings are carried on, in this basin, at a very great depth. Mr. Dunn examined some of them, in the Mons district 180 fathoms=1080 feet in depth, where they were working the *upper or Flenu beds;* and as these collieries were known to be situated very near to the top of the basin, it was computed, that a sinking of 900 fathoms,=5400 feet, would be required to command the lowest coal.

Various modes and experiments have been adopted in the Belgian coal-fields, for the purpose of lighting and ventilation. These important objects

form the subject of numerous memoirs, which have been from time to time, addressed to the government by men of skill and science.

Air pumps have been employed in some of the deep mines for extracting the impure air. The first air pump was erected in 1830, in the coal district of Mons.

At the mine "Sacre Madame," a pair of air pumps are worked by a ten horse power engine; each cylinder being six feet nine inches in diameter; exhausting five thousand one hundred and twenty cubic feet per minute.

The most powerful air pump is that of L'Esperance, near to Seraing, which extracts 282 cubic feet of air per second, = 16,920 feet per minute.*

Mr. Dunn, an excellent modern authority, states that in the neighbourhood of Jemappe, the pits are worked at 347 metres, or 1140 feet in depth. The Grand Hornu colliery, in the Mons district, which has been illustrated by the published section of its immense system of coal beds, is 990 feet deep.†

In the Produit mine, the twenty-nine upper seams are worked by one company, and the twenty-two seams below the first group belong to and are worked by another company. Sixty-nine other coal beds yet lie beneath the latter series, but have not yet been reached. To work the lowest of these, would, it is computed by M. Von Dechen, require a sinking to the depth of *five thousand four hundred feet* at least, or by the estimate of the Belgian engineers, to *six thousand feet* below the surface.

This portion of the coal-field possesses great geological interest. It is covered by the chalk formation, of from fifteen to sixty yards in thickness. In one of the shafts of the colliery of Grand Hornu they have penetrated through two hundred and ten feet of overlying chalk; the lower twenty feet of which contain layers of flints. Between these and the ordinary coal measures there appears to be only a bed of four or five feet of blue shale or clay. In many cases this overlying chalk has been proved of the thickness of four hundred feet, particularly in the French portion of the coal basin.

By direction of the government, the descent to and ascent from the coal mines is effected by separate shafts, in which ladders, often quite perpendicular, are placed, for the use of every person employed in the workings. The fatigue and waste of human strength in this laborious process can scarcely be appreciated except by those who are practically conversant with the matter. The workmen are forbidden to descend in the *cuffats* or tubs which are used for the conveyance of the coals to the surface.

Some improvement for the convenience and safety of the Belgian miners have been latterly introduced. In 1845, a committee of French mining engineers visited Belgium, for the purpose of examining a new machine for ascending and descending coal pits.

In 1844, according to the report of M. Briavionne, the coal mines of this district had been worked out to the mean depth of eight hundred and ten feet.

FIRST DIVISION—SECOND DISTRICT.

Basin of Charleroi, Western or Hainault District.

Properly speaking, this coal district is a prolongation of that of Mons just described, which here attains its greatest breadth; being at Charleroi

* Dunn's View of the Coal Trade, 1844, p. 179.

† This part of the coal-field is interrupted by an extraordinary series of doublings and zig-zags, which pervade all the seams, and which Mr. Dunn likens to the course of lightning.

ten miles and a half from north to south, and twelve miles and a quarter in length. The population of Charleroi is chiefly occupied in working the coal mines of the district, and in the iron foundries and glass works.

In 1840, there were of fixed and provisional concessions 85, comprising 30,686 hectares, or 75,886 English acres.

The number of pits in operation, and in construction, were 96 in 1834, and 263 in 1848. Their average depth, in 1838, was 300 feet, number of working mines, 8,345.

Quantity of coal raised in 1829, 399,153 tons; in 1838, 724,360 tons; in 1839, 838,551 tons; 1845, 1,453,946 tons. Three sixths of this coal was of good quality; two sixths middling, and the remaining sixth part inferior, called "houille maigre."

The facilities furnished by the coal of this district to manufactures, have given, latterly, a great impulse to that description of industry. At Charleroi, four thousand mechanics, in 1836, and six thousand in 1842, were employed in the manufacture of nails alone; besides several thousand workmen engaged in making the iron.

The coals from the Charleroi mines supply the great centres of industry; the blast furnaces, the glass-houses, the refineries, &c., and a great portion of them go into Brabant and down the Sambre and the Meuse. There is now also a railroad for the conveyance of the coal from Charleroi to Brussels.

The best Charleroi coal obtains about the same price at the pit's mouth as that of Mons: as shown in the following statement.

	Years.	Belgian prices per ton.		U. S. currency.		Eng. cur.
						s. d.
Mons coal,	1836	7 to 8 francs	=	$1.50		
	1837	12 to 14 francs	=	2.50		
	1838	best,		4.50	=	19.10
	1842	20 francs "	=	3.86	=	19.02
	1844	20 francs "	=	3.86	=	19.02
Charleroi Coal,	1836	14 francs	=	2.66	=	11.03
	1837	19 francs	=	3.75	=	15.04
	1838	best,		4.96	=	20.06
	1842	20 francs "	=	3.86	=	19.02
	1844	19.61 fr. "	=	3.78	=	17.06

We have not quoted the prices of the middling and inferior qualities, but they are, in general, only from two-thirds down to one-third of the above prices. It is impossible to be exact, as great discrepancies appear in the returns; and, moreover, great attention is required in designating the peculiar quality of coal quoted, from among such a variety of gradations.

It was in consequence of the great advance in the price and the constantly increasing demand for coal in manufactures, that the Belgian government, acceding to the wishes of the people, admitted the English coal free of duty. We see that a precisely similar series of circumstances led, almost simultaneously, both the Belgian and the French governments to countenance the introduction of English coal; to the great advantage of the manufacturers of the first named countries.

Since 1826, fifty-eight large high furnaces, employing coke alone, have been constructed in Belgium. Their average production is about three thousand tons per annum of cast iron, each. According to M. Drouot, the average cost of constructing each of these high furnaces, as well as the

establishment of the kilns for the necessary fabrication of the coke, was 500,000 francs, = £19,312 sterling, or $93,470 U. S.*

The principal employment of the coal of the Charleroi district is in the state of coke, in these high furnaces.

At Charleroi, the different qualities of coal are distinguished by the three following names or divisions.

	Each of these qualities is sub-divided into classes, viz.
I. Fat coal, *gras*.	*Gros.*—Pieces selected at the mine; picked large coal.
	Toute-venant.—The remainder, after selection of the *gros*.
II. Medium coal, *demi-gras*.	*Gaillette.*—A size smaller than the *gros*, but which must be not less than six inches square.
	Gailletterie.—The coal which remains after deducting the *Gaillette* and the *Menu*, passing through a sifter of
III. Lean coal, *meagre*.	an inch and quarter openings.
	Menu.—The coal which is passed through a *cribble* or sieve, whose meshes are 1¼ inch wide.

There are as many prices in the market as correspond with these fifteen subdivisions of quality.

SECOND DIVISION—THIRD AND FOURTH DISTRICTS.

Provinces of Namur and Luxembourg.

In the province of Namur, between the communes of Thon and Samson, is the point of division between the two great coal basins of Belgium. The eastern basin or division, as has been previously indicated, is prolonged into the province of Liege, and even into Prussia. The western basin, after having traversed the province of Namur, following the valley of the Sambre, continues across the Arrondissements of Charleroi and Mons, and passes into France, as before described.

The province of Namur contains portions of each of these two basins. That part which is within the limits of the eastern basin, is only about two leagues in length; and its area, up to the boundary of the province of Liege, is estimated to contain about 2,317 hectares, = 5,725 English acres.

The area which falls within the western basin, in this province, is about six leagues in length, with a superficial extent conceded of 12,157 hectares or 29,040 English acres in 1844.

Statistical Table of the Second Division.

Years.	Fixed. Concessions.	Concessions in activity.	Concessions not in activity.	Area in Hectares of 2,471 Eng. a.	Production in tons.
1822	4	62			
1828	37	56			
1836	37	46	23	10,516	79,174
1838	37	57	33	11,452	103.954
1840	39	80	15	11,568	125,058
1842	40	70	8	12,157	135,378
1844	70	67	6		134,904
4845	"	"	"		161,873

* M. Drouot, on the construction of the high coke-furnaces at Maubeuge. Annales des Mines, tome IV. p. 283, 1844.

	Years 1828.	1838.	1844.
Maximum depth of the working pits in English feet,	344	984	852
Minimum depth, - - - - - -	35	32	"
Mean depth of all the pits, - - - - -	98	147	157

It is observable, that whilst the production of these mines has, during twenty years, been regularly increasing, the number of the shafts, serving for extraction, has diminished. This apparent anomaly is explained by the progress of the arts of mining; which, while reducing the number of the pits, yet enables a greater quantity of the combustible to be raised.*

The coals mined in this province are consumed almost entirely by the inhabitants. A small portion is exported to France, by the Meuse.

Through the facilities afforded by a ready snpply of coal at Namur, the manufacture of cutlery there, gives constant employment to five thousand workmen. Namur has been styled the Sheffield of Belgium.

The solé colliery establishment, which exists in the province of Luxembourg (fourth district) has only been in activity since 1840.

THIRD DIVISION—FIFTH, SIXTH, AND SEVENTH DISTRICTS.

Provinces of Liege and Limbourg.—The Eastern Division or Basin of the Meuse.

This coal-field extends through this province thirty-three miles; its maximum breadth is opposite to Liege, where it is nine miles wide.

Before the treaty of peace in 1831, Belgium possessed several mines of coal upon the right bank of the Meuse, in the province of Limbourg; but these collieries formed part of the territory ceded to Holland.

Statistics of the Eastern Coal-field.

	On the left bank of the Meuse	Right ba'k of the Meuse.	1838. Total.	1844. Total.	1845. Total.
Mines or concessions, definite and provisional, - - - -	60	66	115	112	112
Definitely conceded, - - -	33	35	115	83	
Provisionally appropriated, - -	27	20		29	31
Pits in activity and in construction,	64	57	115	99	114
Working miners, - - -	6,373	4,275	10,646	9,661	11,002
Area of concessions, hectares,			28,585	29,721	
Fixed and provisional, acres,			70,631		1,127,181
Coal extracted, tons,			740 408	1,019,908	
Value of the coal, francs,			10,315,082	8,173,333	
Steam Engines, raising & drainage,			90	106	106
Horse power of the same, - -			4,480	5,843	5,691
Geol. area of the coal basin, hectares,			41,745		
Geol. area of the coal basin, acres,			103,151		
Mines worked, hectares,			99	78	
Not worked, hectares,			11	37	
Pits in work, - - - -			110	92	
Not in work, - - - -			18	7	

The coal seams are exceedingly numerous, although less so than other parts of the Belgian coal-fields. Sixty-one beds occur on the mountain of Saint Giles. On the subject of quality it has been remarked that, although there is no position in this remarkable series, where the best coal prevails, yet, in relation to individual coal seams, as in almost all mines, it is seen

* Rapport au Roi, 1842.

that the middle part, and the bottom of the veins, are always the places of the best coal, and that the upper part of the beds is almost constantly the poorest.

The number of pits at work in this district in 1828, was 100; in 1835, 87; in 1838, 115; and in 1841, 138. At the present time they are yet more numerous. The mines, just without the gate of the city of Liegè, towards Brussels, are about seven hundred and twenty feet deep. The deepest coal pit, that of L'Esperance, at Seraing, in this province, is 1476 feet deep.

There is a generally received opinion, respecting the quality of the Belgian coal, that the deeper it is pursued the more bituminous it becomes.

M. Gennetè states that the greater or less thickness of stony or slaty strata, interposing between the coal seams, has no influence upon the coal itself. There is no relation or affinity with the different depths in the series from whence they are taken. Thus, in the lowest veins, as well as in those in the middle, and those nearest the surface, are found the equal gradations of very good, of middling, and of bad coals.

One of the heaviest charges on coal in Belgium is the scarcity and consequent high price of the timber required to support the mine workings. Notwithstanding the abundance of coal in this field, it is expensive, as the cost of raising it has been as high as ten francs per ton.

The produce of the Liege coal-field is mostly consumed in the district. The surplus is conveyed to France and Holland, hitherto almost entirely by the navigation of the Meuse; but since 1836, railroads have been introduced, and are connected with several collieries.

By the official reports, it is shown that the interior consumption, owing to the great activity given to industry, particularly that of the metallurgic arts, nearly doubled itself between 1828 and 1838.

The production of coal in this province in 1845 was 25 per cent. more than that of 1844.

In 1842, upwards of twenty thousand workmen were employed in Liege and the neighbourhood in the iron works. In fact, Liege may be regarded as the Birmingham, as Namur has been styled the Sheffield, of the European continent. As an instance of the amount of one department of manufacture in Liege, it may be mentioned that in the four years previous to 1859, there were manufactured here,—

Fowling pieces, 551,609—Pistols, 276,795—Muskets, 202,201—Total, 1,030,605.

The value of these articles, in one only of the four years, was estimated at seven millions of francs.

The number of cannon, of all descriptions, manufactured at Liege, is astonishing. In 1846, one establishment produced 9,605; another, 53,765; a third, 17,948; a fourth, 11,548; and a fifth, above 10,000.

The great iron works of Seraing, founded by Cockerill, employ day and night upwards of 4200 persons, and extend over a space of 140 acres. Of iron, it can supply about 13,000 tons annually, and possesses immense coal mines. It contained, in 1847, twenty-seven steam engines, of 1050 horse power, six high furnaces, and vast establishments, of all kinds, for the manufacturing of iron. It may be truly said of this vast concern, that it is one of the most remarkable establishments in the world.*

* London Mining Journal, Sept. 4, 1847.

Small detached Coal Basins in Belgium.

Province of Namur.—Besides the coal-fields already described, this province contains two small accessory basins, where the existence of coal has been recognized, although it has not been developed to an amount sufficient to establish a colliery.

Province of Limbourg.—Here are three little isolated coal basins,—that of Modave, of Theux, and of Bende et Ocquier. The last only comprises two concessions or mines. The small basin of Theux has only received some unsatisfactory reconnoissances.*

Present condition and prospects of the Belgian Coal Mines.

Mr. Dunn's recent investigations in this field have led to some conclusions of an unexpected nature; and as the opinions of a practical authority are entitled to consideration, in an article like this, we cannot close this section without citing them. It appears that this writer is somewhat unfavourably impressed with the system generally adopted for the extraction of the coal within this deep basin.

"Notwithstanding the great and laudable pains taken by the government in the education of mining engineers, and the literary and scientific acquirements exhibited by many of them, in the publication of the different essays on the prevention of accidents in the mines, I am free to confess, that the result of my observation is, that a great deficiency exists in respect to safe and economical measures, for carrying on these coal mines; especially in the deep mines which I saw."

The reasons which have led to this conclusion are stated at some length. He adds:—"I have been induced to go more into detail upon these matters, since I perused an extract from a report, lately made by the engineer in chief of the mines of the Borinage and of the basin of Charleroi, Mons. Briavionne, in which he predicts, that at the end of twenty years the coal mines of Western Belgium will have arrived at the last stage of profitable working. He says, that the mean deepening of the pits has, of late years, progressed at the rate of fifteen metres [=49 feet,] per annum; and, at the present moment, the works have attained a mean depth of 247 metres [=134 fathoms or 810 feet] in the district west of Mons; and 147 metres [=80 fathoms=482 feet] in those of the centre and of Charleroi. Supposing that these workings be so equalized as to reach altogether to the depth which they would seem not destined to exceed,—that is, 500 metres [=268 fathoms=1608 feet],—they would, before twenty years, have arrived at this stage everywhere; and the coal [assuming it to be in abundance beyond this limit,] would be so costly and difficult of extraction, and so expensive, as to take it out of the reach of the common uses of this day."

"This announcement," remarks Mr. Dunn, "comes with appalling force upon the numerous joint-stock companies, which were established in 1836–7, when people thought themselves fortunate if they could only obtain a share in these concerns, at ever so exorbitant a rate."

According to the above quoted report of M. Briavionne, Belgium is travelling towards a momentous crisis; and I am much inclined to confirm the writer's opinion, that, according to the present plan of carrying on the collieries, notwithstanding the high price received for the coals, yet that coal

* Rapport, Statistique de la Belgique, 1842.

will not be found workable to profit, below the depth of 250 or 260 fathoms; inasmuch as the deeper they go, the more destructive and unmanageable will be the effects of the pressure."*

By the official investigations made by the government mining engineers, as to the probable duration of the coal mines of Belgium, the basin of Mons is not expected to yield after another century, even at the rate of the present annual extraction; and as the fire-damp is so general, many pits will become extinct long before half, or even a quarter, of that period.†

At the present period, there appears to be no relaxation in the coal business of this country. Even in 1846, a new impetus was given to the working of the Belgian coal-fields. The discovery of several very considerable coal seams, of excellent quality, was then announced, and some new concessions for the working of them were granted.

Belgium has but just recovered from the effects of excessive speculation, over production, and the sudden establishment, a few years since, of a vast number of companies for working coal mines, before adequate markets could be established. A crowd of new men, adventurers, and speculators, without restraint, suddenly appeared; and exposed the honest producers to ruin by the rashness of these ignorant undertakers. Formerly, each worked with his own capital: all this is changed. Agents, having but little personal interest, managed the affairs of societies, justly named *anonymous.* Economy did not preside in the formation of a great proportion of those companies. They constructed superb palaces: they founded speculations upon exorbitant and transitory prices; and, on the day of awakening, they found that they had squandered immense capital; had created the means of considerable production, for an end which it was difficult to attain.

During the years 1835 to 1838, nominal capitals, to the amount of eight hundred millions of francs, [thirty-two millions of pounds sterling, of one hundred and fifty-five millions, two hundred thousand dollars,] were employed in establishing companies, either anonymous or in partnership; and of which capital not less than fifteen millions of francs were actually expended in these objects.

Between 1830 and 1839, nearly four millions sterling formed the capital of new associations, which established themselves in Belgium, for the purpose of working the coal mines.‡

The faults that England committed in 1824 and 1825,§ were, ten years later, renewed here. These errors have left their traces; a financial and commercial crises yet presses upon Belgium.‖

Of the 307 coal establishments which Belgium possesses, [1843,] eighty-three have been acquired since about ten years, by anonymous societies. The relative position of the old and the new establishments, in 1834, was as follows:

		Tons
The 83 new companies produced from	92 working pits or collieries,	899,871
The 224 old estab'ts yielded from	249 mines,	1,543,697
	341	2,443,568

* View of the coal trade, by Mathias Dunn, 1844, p. 195.
† Mining Journal of London, Dec. 26, 1846.
‡ M. Briavonne "Sur l'industrié de la Belgique," 1839.
§ In 1824, and the first months of 1825, the Parliament of England authorized the formation of 276 companies, whose aggregate nominal capital was £174,114,050 sterling,—or 4,352,850,950 francs =$842,712,000.
‖ Bulletin de la Commission centrale de Statistique, 1843.

In 1838, the 83 new companies produced from	271	working pits,	1,285,427
The 224 old societies yielded from	389	pits,	1,974,844
	660	Tons,	3,260,271

The increase in the number of sites of extraction, during these last years, or from 1834 to 1838, is much more perceptible among the new series than in the old establishments. While the latter increased at the rate of fifty-six per cent., the former advanced their points of production at the rate of one hundred and ninety-four per cent.

To the foregoing return succeeds another period of six years, from 1839 to 1844:

	Tons.
The 93 anonymous societies, "societés financières,"	
extracted from 257 pits in 1840, - - -	1,845,499
" " 225 " in 1842, - - -	2,041,226
" " 225 " in 1844, - - -	2,028,102
The 219 ancient companies or individual mine owners,*	
extracted from 338 pits in 1840, - - -	2,084,575
" " 345 " in 1842, - - -	2,100,126
" " 312 " in 1844, - - -	2,419,138

From these details we can now have a clearer view than heretofore, of the relative advances made during the eleven years, from 1834 to 1844, in the number of collieries, and the amount of coal raised respectively by these two classes of proprietors.

The ancient companies' number of working pits in 1834, 249; and in 1844, 312; increase 25 per cent.

The new associations' number of working pits in 1834, 92, and in 1844, 225; increase 144 per cent.

The ancient companies raised in 1834, 1,543,697 tons of coal; and in 1844, 2,028,102 tons; increase 31 per cent.

The new societies raised in 1834, 899,871 tons of coal; and in 1844, 2,419,138 tons; increase 169 per cent.

The influence of capital is also seen in regard to production. While the old associations increased at the rate of twenty-four per cent., the anonymous societies advanced their production, in the same term of years, forty-two per cent.† We have no means of pursuing the parallel to a later period.

M. Desmaisières, minister of public works, the author of the report from which we have so freely quoted, thus concludes this branch of his subject. "Since 1838, to a state of fictitious prosperity, has succeeded a crisis but too real. The nation has expended in vain, in behalf of mineral and metallurgic industry, resources which might have been better employed; but whatever evils may have befallen the adventurers, they have had the effect of benefiting the consumers.

In order to form an accurate judgment respecting the operations of the past years, we must await the results of an ulterior experience. We have desired only to prove and to exhibit a great characteristic fact, and to deduce from it the approaching consequences.

Belgium will always find in the industrious and persevering spirit of her population, in her habits of economy, in the riches of her soil, in the improvement of her means of communication, already so numerous, the elements

* Compte rendu de 1839–1844.

† Rapport du Roi. Statistique de la Belgique, XLVII.

of success and prosperity. The confidence which we have in the future must not make us conceal the imprudences which have been previously committed. The situation of things, as revealed by the details of this report, can only be that of a people advanced in industry. We are now enabled to develope our forces and our resources. The future is for the workers."

M. A. Visschers, writing at a later period, expresses corresponding opinions, and considers that it is not so much the facilities of production that are necessary to Belgium, as outlets for her coal and iron. For those who, in preceding years, had favoured the false movement of accelerated production, without an adequate market, it seems as if they had entertained but one care—that of realizing the finest industrial schemes. They troubled themselves very little about the future.

"An *industriel* of this epoque naively communicated to us his projects. When we asked what he would do in the event of his obtaining no sale for his coal? 'We will construct,' said he, 'high furnaces.' But if you could not sell your pig iron? 'We will fabricate the iron: we will erect workshops for construction.'"

It was the skilful mechanicians who held this language, not the true economists. The greatest, the most ingenious of these, Mr. J. Cockerill, is an example. There was no enterprise originated in which he did not conceive himself competent to bear a part. In the last years of his life, he showed us the list of the industrial establishments with which he was connected. This list numbered seventy-two undertakings, all created upon the grandest scale. This man, to whose memory his workmen desire to erect a statue, has perished, like all men of genius, by the abuse of his principle.

To the sounder views of the present producers, Mr. Visschers renders due homage. "They have placed, at length, the question of production upon its true basis. They endeavour to lower their costs: they limit themselves to solicit from the government improvements in the interior channels of communication, and its assistance in negotiating treaties of commerce with neighbouring people. These are the certain pledges of success for the future. The market now-a-days belongs to those who work the best and the cheapest; outlets (debouches) increase by the creation of new avenues for transportation, particularly the railroads; international relations are ameliorated; barriers are lowered before reciprocity of interests.

With the resources which the soil of Belgium presents, we ought not to despair of making up for the losses of the past. We have drawn from the history of preceding years a confirmation of this principle in political economy, that labour is the sole source of wealth. To the efforts of the intelligent, then, we look for repairing the evils which imprudence has occasioned."*

A synoptical Table, or general *coup d'œil* of the coal districts of the kingdom of Belgium, exhibiting the number and areas of concessions, the number of mines and pits in operation, steam engines and horse power, working miners, quantity of coal extracted, average quantity raised annually by each miner, average wages of each miner, value of the coal at the pit's mouth, greatest depth of coal mines, average depth of coal mines; chiefly prepared from the "Rapport au Roi," published in 1842 by the minister of public works, and from the "Compte rendu de 1839–1844," recently published.

* De l'état actuel de l'exploitation minérale et de l'industrie metallurgique en Belgique.

Classification of details.	Years.	1st division. Hainault, Mons, Tournay and Charleroy.	2d division. Namur and Luxembourg.	3d division. Liege and Limbourg.	Sums total, and mean results.
Number of concessions for mines,	1839	59	38	69	166
	1842	68	40	80	188
	1844	78	70	83	201
Mines permitted provisionally,	1839	95	none.	41	136
	1842	83	none.	29	112
	1844	79	none.	29	108
Area of surface conceded, in hectares of 2,471 Engl. acres,	1840	39,251	11,452	18,473	69,176
	1842	41,695	11,568	21,326	74,589
	1844	54,645	12,157	22,349	89,151
Area of provisional concessions, hectares,	1840	44,406	none.	10,351	54,737
	1842	42,265	none.	8,071	50,336
	1844	32,905	none.	7,372	40,277
Geological areas of the coal basins, acres,		75,725	16,643	41,745	134,113
Number of mines in operation,	1839	123	35	99	257
	1842	110	36	83	229
	1844	107	30	75	212
Number of mines not in work,	1839	31	3	11	45
	1842	41	4	26	71
	1844	50	10	37	97
Number of coal pits in operation,	1839	293	80	110	483
	1842	279	70	101	450
	1844	247	67	92	406
Number of coal pits in construction,	1839	101	15	18	134
	1842	102	8	8	118
	1844	121	6	7	134
Maximum depth of the mines, in English feet,	1839	1,508	905		"
	1842	1,508	852		"
	1844	1,508	852	1,672	"
Average depth of the mines, in English feet,	1839	475	134		"
	1842	606	154		"
	1844	639	158	495	"
Number of steam engines engaged in raising the coal,	1839	224	6	59	289
	1842	263	12	75	350
	1844	269	12	67	348
Steam engines raising water for drainage,	1839	66	0	31	97
	1842	77	1	35	113
	1844	81	2	39	122
Steam engines employed in ventilation,	1839	7	"	1	8
	1842	21	"	2	23
	1844	28	"	2	30
Number of horse power in these three classes of steam engines,	1844	16,752	318	5,771	22,841
Number of workmen in the mines,	1829	19,593	750	9,350	29,693
	1839	24,793	1,165	11,089	37,047
	1842	27,955	1,159	10,788	39,902
	1844	27,719	1,110	9,661	38,490
Mean wages of a working collier per day,	1844	1 fr. 61 c.	1 fr. 31 c.	1 fr. 46 c.	
Number of tons of coal, of 1000 kilogrammes each, raised in each division,	1830	1,913,677	50,000	590,084	2,553,761
	1836	2,349,374	79,174	627,916	3,056,464
	1839	2,590,011	124,397	755,752	3,479,160
	1842	3,059,183	135,378	946,902	4,141,463
	1844	3,290,728	134,904	1,019,908	4,445,240
	1846	3,671,023	161,873	1,127,181	4,960,077
Value of the product at the pit's mouth, in francs of 9.69*d*. English, or \$0.19¼ U. S. currency,	1838	31,718,260	784,838	10,315,082	42,818,180
	1839	34,346,519	824,824	9,952,252	45,123,595
	1842	28,708,753	707,924	8,621,649	38,038,326
	1844	30,990,772	680,086	8,173,333	39,844,191
Value of the coal raised in the kingdom of France, in francs,	1838				29,078,083
	1844				35,497,000
Average production of each pit, in tonneaux of 1000 kilogrammes,	1839	8,870	1,555	6,870	7,203
	1842	10,965	1,934	9,375	9,203
	1844	13,322	2,013	11,083	10,949

Classification of details.	Years.	1st division. Hainault, Mons. Tournay and Charleroy.	2d division. Namur and Luxembourg.	3d division. Liege and Limbourg.	Sums total. and mean results.
Average number of tons raised by 100 men annually,	1844				15,549
Average quantity of coal annually raised by each miner in Belgian tons,	1836	112 t. 51 d.	89.05	85.14	104.87
	1839				93.91
	1842				103.79
	1844				115.49
Do. in France,	1840				115,36
Mean selling price in Belgium per ton of 1000 kilog., in francs, best coal,	1839	undeter-	6.63	14 81	
	1844	mined.	5.10	8.90	
Mean daily price of miner's wages in France, Mons district,	1839	2 fr. 87	1 fr. 45	1.82	
	1844	2 25	1 31	1.46	
Charleroy "	1839	2 40			
	1844	1 90			

Concessions, fixed and provisionary.—"Attribuée provisoirement."—The ancient custom in Belgium, as explained in the "Statistical Bulletin" of 1843, was to limit the number of coal seams (to be worked) in the leases. Different lettings took place within the same area; each company, in turn, being empowered to sink through the other's concessions, in order to reach its own. This state of things has always occasioned great inconvenience and confusion. The government desires to remedy this evil; but it cannot do so effectually, so long as the existing leases are in force and unexpired.

Royalty Rents on the Coal and Metallurgic Mines.—The law of the 24th of April, 1810, fixed the principle as follows:—1st. A *fixed*, or *sleeping rent*, in proportion to the extent of coal leased, or promised to be leased, and is regulated accordingly, from time to time. 2d. A *proportional rent*, [redevance,] is fixed annually by government, which rent is levied, not exceeding five per cent., upon the net produce of the mine. The mode of taking such amount is regulated by an imperial decree of the 6th of May, 1811. Subsequently to the year 1823, the *tonnage rent* had been fixed at two and a half per cent. upon the net produce of the mines.

Since 1834, there has been comprised in this account, the sum which is annually paid by the society of the *Vielle Montagne*, amounting to 7500 francs.*

The following is a condensed statement of the periodical amount of these rents:

Years.	Metallurgic Mines. Fixed Rents.	Coal Mines. Proportion and Fixed Rents.
1823	14,244 *fr.*	99,919 *fr.*
1830	17,896	96,148
1835	16,701	51,678
1838	15,761	170,571
1840	15,910	141,040
1842	16,129	145,669
1844	14,107	107,637

Previously to this epoch, the laws, enacted in 1816 and 1819, had established an excise impost [droit d'accise] upon coal. The suppression of this tax was regarded as a benefit by the explorers of mines.

* Rapport au Roi, Mines, Usines mineralogiques, Machines à vapeur, 1842, p. 431, 3.

Prepared Fuel.—In Flanders, and in several parts of Germany, particularly in the duchies of Juliers and Bergens, where coals are in use as fuel, they are commonly prepared by pounding the pieces to powder, and mixing them up with an equal quantity of clay. The mass is kneaded together into cakes, which, after being well dried, are kept dry for use. Precisely the same process is now adopted in South Wales, where it has been in use from time immemorial, as it also has been similarly employed in China.

It has been found by long experience, that the expense attending this preparation is amply repaid by the improvement of the fuel. The pulverized coals, thus mixed with clay, not only burn longer, but give much more heat, than when they are burned in their crude state.

It will doubtless appear extraordinary to those who have not considered the subject with some attention, that the quantity of heat, produced in the combustion of any given quantity of coal, should be increased by mixing those coals with clay, mud, or ooze, which are obviously incombustible bodies, but the fact is certain.*

Peat.—This vegetable substance is of great value as a cheap fuel for the poorer classes, and abounds throughout the country, particularly in those parts of it which are most remote from coal. However, in this instance, Belgium, which is so productive in the mineral combustible, is less bountifully supplied with peat, its substitute, than is her neighbour, Holland, which possesses no coal mines. Thus have the gifts of nature been impartially distributed; for it is a fortunate provision of Providence that those northern and temperate regions to which coal has, in many instances, been denied, seem best fitted for the production of those aquatic plants which contribute to form turf or peat; and as fuel in those regions is indispensable to man—is one of the first necessaries of his life—the absence of mineral coal is, in great measure compensated for, by the abundant and reproductive supply of a vegetable fuel whose useful and multifarious properties are every day becoming more apparent.

We may be permitted to add here, that animal remains, possessing considerable interest, are occasionally extracted from the turbaries of Belgium. A jaw of a dog was found not long ago, at the depth of ten feet, which M. Puel, to whom this relique was committed for examination, recognized as belonging to the variety known as the Esquimaux dog.†

Canals of Belgium.—The total length of navigation by the twenty-two finished canals, is 286 English miles; and other lines are in progress. All these are, for the most part, supported by the transportation of coal and iron. The tolls upon them are reasonable; the works are carefully maintained, and, consequently, they yield great service to the country.

Navigable Rivers, in 1846, 598 miles; hence there is a total extent of inland navigation of 884 English miles.

Railroads.—Nothing has had so beneficial an effect on the Belgian coal trade as the establishment of railroads, during the last ten years. In fact, "Belgium is the first State in Europe in which a general system of railways has been planned and executed by the government at the public cost; and, certainly, it is an honourable distinction to have given the first example of such a national and systematic provision of the means of rapid communication."‡

The number of railroads now in progress and projected, added to those

* Gray's Operative Chemist. † Bulletin de la Société Géologique de France, tome X. p. 118, 126. ‡ McCulloch's Belgium.

already in operation, is really extraordinary. No country in the world, in proportion to its extent, will possess so many miles of railway as Belgium. All this result is owing to the prevalence of those vast depositories of coal and iron within her boundaries.

In 1842, there were in operation, in this kingdom, 282 miles of railway; the average cost of constructing which was £12,120 sterling, or $58,660 per mile, which is less than half the average cost of railways in England, and more than double the cost per mile of the completed railroads of the United States.

On the 1st of January, 1846, there had been constructed, in this country, seven railways, whose aggregate length was 386¼ English miles, at a cost of £5,789,872 sterling, or $28,022,980, averaging £16,600=$80,344 per mile.

In Great Britain the average cost of 1900 miles of railroad, up to 1846, was £34,710=$168,000, while the 4,865 miles completed in the United States, many of them single tracks only, cost £5,564=$25,932 per mile.

Steam Engines.—The first pump, worked through the agency of fire, was established at Liege, about the year 1723.

In the arrondissement of Charleroy this improved system was introduced in 1725—an epoch which was distinguished by the establishment, at Lodelinsart, of the first steam engine, by a Liegeois, named Mathew Misonne. In the district of Mons, the first steam engine was erected about the year 1734.

The first machine, for the double purpose of drainage and for the extraction of coal, was erected in the province of Liege, in 1810, at the colliery of Plomterie; but in the province of Hainault engines of this description were in activity as early as 1807.*

In France, the first steam machine, which was employed for draining a coal mine, was erected in 1749, at Litry; and it was in the same mine, in the year 1810, that they employed, for the first time, steam power to raise the coal.

In 1839, the number of steam engines employed in the Belgian collieries was—

		No. of Engines.	Horse Power.
In the extraction, or raising the coal to the surface,		266 of	6846
In draining, and pumping the mines,		102	8636
In the purposes of ventilation,		8	122
	Total in 1839,	376 =	15,604
	Total in 1844,	503 =	23,003
In 1840, the total number of steam engines in all Belgium, engaged in mining, manufacturing, and navigation, was		1,049 =	26,056
In 1844, the number had increased to		1,448	37,370
Locomotives employed on the national railways,	In 1840,	122	6,053
	In 1844,	146	7,955
Steamboats† " " "	In 1838,	5	744
	In 1844,	10	891

Caisses de Secours.—Provident Institutions, Relief funds, Caisses de prévoyance, also mining accidents and casualties, in Belgium, are treated at length in a preliminary chapter.

* Bulletin de Commission Statistique, Royaume de Belgique, 1843.
† Compte rendu de 1839, 1844.

General Review of the Minerallurgic establishments in Belgium at the end of 1844.

	No. of Iron Works.	Steel.	Lead.	Copper.	Zinc.	Alum.	Glass
Hainault,	100						25
Namur,	71	1	1	8			1
Luxembourg,	31						
Liege,	62	1	2	4	6	1	3
Brabant,	10		1	1			
Total, 329	274	2	4	13	6	1	29

Metalliferous Mines, chiefly Iron Ore.—There are a few mines of lead, pyrites, and manganese in the Belgian provinces, but iron ore is above all, distributed in the greatest profusion. It is contained in great deposits, in the form of basins, and also in the state of immense pipes or funnels in limestone—other accumulations fill cavities and depressions in the oolitic limestone, and elsewhere occur in great veins. These minerals furnish all the varieties of the best or strong iron. In general, they are treated with charcoal, bnt in some localities mineral coke is employed, especially all the recently erected high furnaces.

The oxides and hydrates of iron have for some years been worked in several communes on the north of the province of Namur and Luxemburg. In Hainault, the workings of iron ore are not very important, and there are no other minerals mined. In Liege, there are mines of iron ore and some of zinc or calamine. Iron ore does not accompany the coal measures, here, but forms separate bands and extensive deposits, towards the Meuse, and extending to the Prussian frontier.

Tables of the working of the metalliferous mines in Belgium, as relates to iron ore.

Divisions.	No. of places of extract. of iron ore.			Concess. for iron mines		Area of Concessions in Hectares.			Number of workmen chiefly in iron.		
	1836.	1838.	1844.	1842.	1844.	1838.	1842.	1844.	1836.	1839.	1844.
Hainault,	121	15	72	2	2	2,559	2,559	2,559	524	120	273
Namur,	1,061	569	428	16	16	35,685	30,337	30,630	3,213	1,318	1,348
Liege,	144	156	88			11,977	12,159		1,067	704	1,187
Total,	1,326	740	588						4,804	2,142	2,808

Divisions,	Tons of iron ore extracted.			High furnaces.		St'm eng. for iron.		Horse power.		Max. d'th in metres.		Mean depth.	
	1836.	1839.	1844.	1838.	1844.	1839.	1844.	1839.	1844.	1839.	1844.	1839.	1844.
Hainault,	39,981	35,700	30,137	34	12					25	32	7	27
Namur,	528,925	113,431	152,954	83	26	5	9	70	209				
Liege,	68,049	43,846	31,286	22	11	1	3	8	67				
Total,	636,955	192,977	214,377	139	49								

The reduction in the last year's produce arose from the excessive supply of the two preceding years, and the consequent encumbering of the maga-

zines. It was the natural result of a superabundant supply. Metallurgic industry, in consequence of the previous excess of production beyond the wants of the consumers, suffered a reaction, the effects of which were considerable losses during the five succeeding years. We have already adverted to this epoch of over production and speculation, and to its injurious influence and results, when treating on the subject of coal. Little more than one half the workmen were employed this year.

In 1838, out of the 270 minerallurgic establishments in the kingdom, 221 were for the treatment and the preparation of iron, of which number 139 were high furnaces. Through the pressure of the times, alluded to, several high furnaces were put out, and in 1841, 8 high coke-furnaces alone, out of 16, were in operation in the province of Liege.*

In 1830 the first high furnace was erected in Charleroi, for the smelting of iron. Seven years after, 1837, there were 25 coke-furnaces in action, producing annually 75,000 tons of metal.

On the termination of its union with France, Belgium possessed 89 high furnaces, 124 forges, and 80 other iron works.

			Tons.
The coke furnaces in Hainault produced of pig iron, in		1839	30,583†
"	"	1844	41,956
"	"	1845	58,135
"	" estimated,	1846	114,000

The condition of the iron establishments in Belgium, in 1838 and 1844, was as reported below.

	Active.	Inactive.	Total.	Active.	Cast iron. Produc. Tons.	Grosfer. Tons.	Total Tons.
In 1838, high furnaces,	59	41	139	49			
" foundries,			47				
" fineries,			17				
" affinaries,	212	36	256	113	106,878	46,913	153,791
" forge hammers,			131				
" Other machines,			263				
Total,			853				

In 1842 there were only 58 blast furnaces in Belgium. Of these, 38 had been out of blast for three years; and of the remaining twenty, not one was paying a dividend to the shareholders. There was not a single furnace at work with the hot blast; and the lowest price at which a ton of forge pig could be produced, under the most favourable circumstances, was £3 14s. sterling = $18.00.‡ The make of iron this year was 121,000 tons,§ and advanced to 150,000 tons in 1845.

The demand for iron has, however, of late years, been much on the increase; not only for the home consumption, in consequence of the progress of railways, from one end of Belgium to the other, but for supplying numerous railways in France. Hundreds of furnaces are now (1847) in blast, where twelve years ago not one was seen, and the others were abandoned.

* Rapport au Roi, 1843, LXVII. and p. 236.
† Report of the Sambre and Meuse Railway Company, July 2, 1846.
‡ Correspondent of the Mining Journal, London, 1842.
§ Traité de fabrication de la Fonte et du Fer, 1845, p. 1288.

The following table sufficiently indicates the periodical condition of the iron trade in one department, during the eventful periods, of which we have been speaking.

Statement of Belgian Iron exported to France.

Years.	Tons.	Years.	Tons.	Years.	Tons.	Years.	Tons.
1821	3,200	1830	2,934	1838	3,678	1842	12,543
1824	3,400	1832	3,178	1839	3,100	1843	21,521
1827	3.587	1834	3,845	1840	5,085	1844	31,387
1828	3,800	1836	9,303	1841	9,029		

The price of iron has, in consequence of this favourable change and its enlarged demand, increased within the last sixteen years, at least from twenty-five to thirty per cent. although there were, in 1846, more than five times the number of furnaces at work than formerly.*

The home consumption of iron, in 1845, was 120,000.

The exportation of unwrought cast iron during the first 6 months of 1845 was 19,000 tons; the first 6 months of 1846, 33,000 tons.

The greater part of this was sent to Germany and France.†

To the foregoing statistics of exportation we have to add the following, showing the relative value of the exportation of iron from England and Belgium.

		England.	Belgium.
Exports of iron for the year	1845	87,500,000	11,400,000
" "	1846	104,000,000	13,500,000
Exports of machinery,	1845	22,500,000	5,000,000
" "	1846	29,000,000	4,000,000

In 1846, Messrs. Sopwith and Smith, civil engineers, reported on the mineralogical capabilities of the district between the Sambre and the Meuse, and upon the apparently exhaustless deposits of iron ore, particularly with reference to the iron mines at Couvin, near the frontier of France. They state that the limestone formation of that district contains vast deposits of iron ore, in pockets or funnel-shaped cavities, which admit of being worked with great facility, owing to their proximity to the surface.

These deposits of iron ore extend upwards of seventy miles, in an east and west direction. For some years, the iron works of this region have remained in a state of inactivity, arising from the commercial embarrassments of 1838 and 1839, which caused so much loss and interruption throughout the whole of the industrial establishments of Belgium. From these great and ruinous causes of depression, many of these works never revived—others in time, began slowly, and under great disadvantages, to resume operations. The most apparent of these difficulties was the want of capital; but, it is stated, the iron works are now almost without exception, doing well.

We infer that English capital, to a large extent, is now brought to bear on the mineral resources of this quarter.

The spirit of mining enterprise is again in great and successful activity in Belgium, arising from the great demand for coal and iron, from the neighbouring countries. Among others, a French company, called the "Société des Charbonages Belges" headed by Baron Rothschild, in 1846,

* Mining Journal, Feb. 21, 1846.
† Report of the Belgian government, in 1846.

obtained a royal ordinance, creating it a *Société anonyme.* The objects of the company are the acquisition of coal pits, mines, railroads, and iron furnaces in Belgium; the charter to exist for 99 years, with a capital of fifteen millions of francs. It is calculated that it will exercise great influence on the coal trade, by increasing its supplies, and finding it new markets, particularly France, through the means of the great northern railroad which is in the hands of the same parties.*

At the commencement of 1847, mining enterprise in Belgium was never known to be in so flourishing a state.

Among other establishments none are on so extensive a scale as the iron works of Seraing, near Liege. Here are 4200 men constantly employed night and day. Eleven steam engines, with an aggregate force of 500 horse power, are in constant operation. The annual supply of iron ore to the furnace is 53,572 tons, and the produce of the rough metal, before manufacture, is estimated at 1,000,000 pounds sterling.

* Paris Correspondent of the Mining Journal, May 23, 1846.

KINGDOM OF PRUSSIA.

PRUSSIAN SYSTEM OF CURRENCY, WEIGHTS AND MEASURES.

Prussian Currency.

1 Frederick single gold ducat, = \$3.97½, United States.

1 Thaler or Prussian Rix-dollar, 3.711 francs, = 3*s.* English—current value, which is divided into 30 silbergros, and each silbergros into 12 pfennigs.

Par value of £1 English in London, 6 dolls. 27 s. gr., and of 1 Prussian dollar = 2*s.* 9½*d.*

£1 English = 5 thalers, 15 gros.

10 Florins = 16*s.* 8*d.*

1 Florin = 20 pence, or 1*s.* 8*d.* English, = \$0.40 United States.

1 Pfennig, = 1-12th of 1 silbergros, = 0.0103 franc.

1 Silbergros, [silver groschen,] = 1.198*d.* English.

Weights.

The Prussian tonne of coal, &c., = 4 quintals, or centners, or scheffels, of about 110 lbs. = 113.38 lbs. avoir., therefore there are nearly 5 Prussian tonnes to 1 English ton; 4 scheffels of 6⅔ bushels each.

1 Lain of coal, = 1000 lbs.

1 Berlin scheffel, or quintal of coal weighs generally 110 lbs. = 113.3 lbs. English, = 51.58 kilog., = 54.94 litres.

1 German tonne, = 1000 kilog., = 10 metrical quintals, = 20 centimes.

1 Prussian quintal, = 55.44 kilog., = 121.98 lbs. English. 18.2 quintals 1 ton English.

The Prussian livre, = 0.47 kilog., is divided into 32 laths.

1 Foudre, = 30 centners of 110 lbs., = 3300 lbs., = 1½ tons, nearly.

100 lbs. Cologne, = 103 lbs. avoir. English.

116 lbs. Cologne, = 1 quintal. The quintal of the Rhine, = 50 kilog.

1 centner, or quintal, of 110 lbs., Cologne weight, = 51.6 kilog., = 113.38 lbs. avoir.

Measure of Capacity.

The Prussian coal measure called a scheffel, or boisseau, is a fraction less than 1½ Imperial English bushel: about 20 of these will weigh one ton.

4 Scheffels, = 1 Prussian tonne, = 54.943 litres.

1 Berlin scheffel, = 3,180 English cubic inches, = 1,479 English bushels, = 52,107 Fr. litres.

1 English Imperial bushel, = 2,150 English cubic inches.

1 Last of wood, = 75 cubic feet Prussian, = 2.32 cubic French metres.

1 Corde of wood, = 3.34 steres, = 1 klafièr.

Measures of Area.

1 Prussian morgen, = 3053 square yards English, = 1.52 English Imperial acres.

15,853 Morgens, = 10 English acres.

Measures of Length.

1 Rhenish foot, legal measure in Prussia, = 0.314 metres French.

1 Berlin foot, = 12.19 English inches, = 3.097 decimetres.

1 Prussian lactre or lachter, = 1,884 metres, = 6.17 feet English. 6 Rhenish feet, = 2.09 metres.

1 Square lachter, = 4,378 metres.

1 German mile, = 7.4089 kilometers, = 4.6 miles English.

Saxony Money,

1 Rix-dollar, = 23 groschen, = 228 pfennigs, = 3*s*. sterling.

£1 Sterling, = 6 rix-dollars and 13¾ gros.

1 Convention dollar, = 32 groschen, = 4*s*. 1½*d*. English.

Weights and Measures.

Coal in Saxony is computed commonly by the bushel or scheffel.

The Saxon boisseau, or scheffel, = 1.743 hectolitre, = 3.045 bushels English, which is about 9.21 bushels to 1 ton.

100 Dresden scheffels are equivalent to 195 of Berlin.

1 Saxon scheffel, therefore, is = 2.884 English bushels, and

10 scheffels are equal to 1 ton English.

1 Last of coals is about 6000 lbs. weight, but is seldom used; = 2⅝ tons English.

GERMAN ASSOCIATION, OR DEUTCHE ZOLLVEREIN.

L'Association Allemagne, Custom-house League, or Prussian Union.

The German Association has, during the thirteen years from its commencement in 1834, to 1847, inclusive, published official statements of the general movement of merchandize and produce within its limits. We introduce from these documents the results as regards mineral coal. The returns to which we have alluded do not make known the values of this trade. This omission has been supplied, approximately, in the *Documens sur le commerce extérieur*, published by the department of commerce, of France.*

With relation to the statistical tables published under this sanction, it is remarked that the most important division of merchandize imported by the association is that of *industrial matters*, in the *rough state*, to the value of 325 millions of francs; and that the most considerable of the exports, is the class of *manufactured articles*, to the extent of 319 millions. This statement is the mean annual amount during the period from 1837 to 1841. In 1843, the total value of the exchanges was estimated at 1400 millions of francs; of which the operations by sea, *via* the ports of Prussia, were about 300 millions.

* Documens sur le commerce extérieur. Faits commerciaux, Juillet, 1844.

Of the article *coal*, there has been an enormous increase; testifying to the progress of the Prussian manufactures and working establishments.

*Commercial movement of Coals in the States of the German Association, or Zollverein.**

Years.	Imported. English tons.	Exported. English tons.	In Transit. English tons.	Total movement of Coals,—tons.	
1834	60,860	218,440	3,460	282,760	For further details, see the Table of *exportation* of coal from the Rhenish provinces of Prussia.
1836	69,370	272,780	4,070	346,220	
1838	99,620	376,960	5,250	481,830	
1840	176,110	348,660	3,250	528,020	
1842	187,250	375,450	4,360	567,060	
1843	251,560	349,150	5,190	605,900	

At the close of 1843, the Zollverein counted ten years of existence. In 1834, it commenced with a population of 23,478,120 inhabitants. In 1843, it numbered 27,623,818 inhabitants, and the following countries:

Kingdoms and Prov's.	Grand Duchies.	Duchies.	Principalities.
1. Prussia, Brandenbourg.	5. Baden.	11. Nassau.	17. Schwazburg.
Prov. Silesia.	6. Hesse Darmstadt.	12. Saxe Altenbourg,	18. Reuss.
Prov. Saxony.	7. Mecklenberg Schwerin.	13. Saxe Weimar.	19. Anhalt.
Westpalia.	8. Luxemburg.	14. Saxe Meiningen.	20. Hohenzollern.
Bas Rhin.	9. Electorate of Hesse.	15. Saxe Cobourg.	21. Waldeck.
Pomerania.	10. Frankfort, free city.	16. Brunswick.	22. Hesse Hombourg.
East Prussia.			
2. Bavaria,			
3. Wurtembourg,			
4. Saxony,			

The foundations of the alliance were laid in 1818. "Next to the efforts of the Prussian government to diffuse the blessings of education, their efforts to introduce a free commercial system into Germany, constitute their best claim to the gratitude and esteem of their own subjects and of the world."†

Table of Coal imported from Great Britain into the German States, and Hanse Towns.						Exported from Prussia, &c., into France.			
Years.	Tons.	Years.	Tons.	Years.	Tons.	Years.	Tons.	Years.	Tons.
1831	44,023	1837	75,785	1841	173,437	1831	2,649	1836	15,271
1832	52,142	1838	89,701	1844	171,865	1832	2,566	1841	167,950
1835	66,055	1839	116,678	1845	227,539	1834	14,844	1842	169,610
1836	62,905	1840	121,391						

The Custom-house quintal of the association, since 1840, is 50 kilogrammes, = 110 lbs.; in 1839 was 51.41 kilogrammes.

Dantzic, { A load or last of wood, = 80 cubic feet.
A last of grain, 30 hectolitres, = 85 bushels, = 2.66 tons.
The last of coal, weighing about 6000 lbs.

The Royal *Tariff* of the Prussian States, and of the German Custom-house Union, fixes on *coal* 1¼ gros, = 2.8*d*. per quintal of 110 lbs. English, = about 5*s*. 1½*d*. per ton, duty on importation, by the Prussian frontier and by the Elbe.

* Mouvement Commercial sur l'exposition de Berlin, 1845.
† McCulloch.—Dictionary of Commerce, supp. p. 62. Février et Mars, 1845.

There is no duty on exported coals.

For the convenience of all the contracting states, it was agreed that from the 1st January, 1839, a coin should be struck, under the name of the money of the association; of the legal value of 2 thalers, or 3½ florins, to be current throughout all the states of the association.*

"The *declared* principle of the league, namely, the commercial and financial union of the German States, is not only one to which no foreign power has any right to object, but is excellent in itself; and is, in fact, the establishment of free trade among the associated states. The numerous customhouses which impeded the internal traffic of Germany have been abolished; an enormous expense previously incurred, in the prevention of smuggling, has been saved; and smuggling itself, with all its immoral consequences, has, so far, been put a stop to. The traveller passes without interruption, from the frontiers of France to those of Russia; from Switzerland to the North Sea. The free interchange of commodities promotes, as a natural consequence, the improvement of communications, the interchange of ideas, and the diffusion of knowledge. The roads are amended; railways are constructed; the rivers are opened to steam navigation. No one can deny that the Zollverein has thus removed many impediments in the way of general civilization and comfort; and has, in so far, been highly beneficial to the German people."†

M. Goldenberg has made a report, addressed to the minister of agriculture and commerce of France, upon the exhibition of the products of German industry, opened at Berlin, the 15th August, 1844, and also the result of his visit, in concert with M. Legentil, to several of the manufacturing and producing districts, in order with greater certainty to ascertain the state of the different industrial operations of Germany. We shall advert to that part of the report which is especially connected with the subject of this volume—namely, the coal, lignite, peat, &c., published in March, 1845.

Combustibles.

Coal.—The Zollverein is very rich in coal basins; but the beds are not always favourably situated in regard to the industrial necessities of the country, and this inconvenience is more especially felt with reference to the smelting of iron, from which they are generally too far distant. It is only in Upper Silesia that the collieries are in immediate proximity to the mineral; but as the coal there is very meagre and produces a bad coke, its employment becomes less advantageous for the fabrication of iron.

The annual production of the principal coal beds of the Zollverein may be summed up as follows;

	Coal basins.	Metrical tonnes.‡	Value francs.
Prussian States.	La Ruhr, in Westphalia, produces about - - - - -	1,000,000	
	Silesia, - - - - -	800,000	
	Saarbruck and provinces of the Bas-Rhin, - - - -	700,000	
German States.	Saxony, (probably underrated)	150,000	
	Bavaria, - - - - -	50,000	
	Duchy of Hesse, - - - -	50,000	
In 1845—Total, - - - - - -		2,750,000	= 24,750,000 fr.

* Bowring's Report. † Edinburgh Review, Jan. 1844—art. the German Zollverein.

‡ The Zollverein tonne is 1014 kilogrammes, yet is frequently estimated as 1000. The English ton is 1000 kilogrammes.

[This is perhaps much underrated, and some small coal districts do not seem to be included.]

This coal has been estimated at the mean value of 9 francs = 7*s.* 3*d.* = $1.75 U. S. per ton, at the place of extraction; which is a little higher than the coal of St. Etienne in France.

Coal Tax. In Prussia, coal is subjected to the tax called *dime*, which therefore, being added, brings up the average price at the mine to 10 francs per tonne.

Consumption of Coal within the Zollverein, annually (1845) 3,000,000 tons.

The English coal entering the Baltic ports were as follows in the years specified. In 1839, 248,369 tons; 1840, 231,752 tons; 1841, 310,277; 1844, 267,171; 1845, 412,026.

Lignite or Brown Coal.—Nature has placed this substance intermediately between true coal and wood. It gives out, commonly, one third more heat than wood; but does not burn so readily as the former. Great abundance is found in several countries of Germany; principally in Prussian Saxony, the Hartz, the Rhine, and the environs of Mersebourg. Very recently some rich beds have been discovered in La Marck, in Grunebarg in Silesia, and above all at Laasau, near Breslau. It is believed that this last locality is susceptible of annually producing many millions of quintals for many centuries to come. The price varies according to the quality, the richness of the beds, and their situation, more or less favorable for consumption. In the Hartz and in the environs of Berlin, it cost from 1 franc 20 cent. to 2 francs the 100 kilogrammes, = 9*s.* 6*d.* to 16*s.* 0*d.* per ton; or from $2.32 to $3.82.

Peat is in very extensive use in Prussia, in Bavaria and Wurtemberg. At Berlin and its environs, it is employed in almost all the workshops, and on account of its application to the production of *gas*, its consumption is regularly augmenting.

The price and the qualities of turf differ greatly in one locality from another. In the north of Germany, the value of the stere or cubic metre of peat varies between 1 fr. 30 cent. and 3 francs.

Wood and Charcoal.—The forests of the Zollverein present very diversified conditions, and the price of the wood varies much according to localities.

Specimens of charcoal were presented at the Berlin Exhibition, in August, 1841; but as the carbonization of wood is as well practised in France as in Germany, the only thing to take into consideration is the question of comparative price.

Gas employed in refining Iron.—The gas of the high furnaces in Germany has been satisfactorily introdnced, employing for this purpose combustibles of inferior quality; such as peat, lignite, and even wood. At Magdesprung, in the Hartz, not only iron is refined, but steel is fabricated, and possesses all the characters of a good quality.

It is expected here to effect an economy of 50 per cent. in the combustible; inasmuch as fifty francs worth of wood, converted into gas, will give a result which they have never yet been able to obtain with less than a mean quantity of charcoal of double the cost. At present the process is kept secret.

The good result of this method, when perfected, will be of the highest importance for northern Germany, which possesses immense deposits of turf and lignite.

In their solid state, these combustibles have hitherto been of little service

in the fabrication of metals; but, reduced to *gas*, they will become a great resource in these countries.

The same process will be no less useful to France, which possesses very rich *turbaries*, of which little use has as yet been made. Wood, for the production of gas, not requiring to be carbonized, will equally become a source of more economical and advantageous employment.

The beneficial results obtained by the use of gas in refining iron,—as much from the economy of the combustible, as from the smallness of the loss and the amelioration of the quality,—render it speedily desirable that the forge-masters should apply themselves with ardour to the study of this process, and introduce it in the iron-works.*

Railroads within the Germanic Union.

	Projected miles.	Completed in 1846.
In the Prussian dominions, - - - -	1063	159
The smaller Germanic states have planned above - - - - - - - - -	1700	600
Those of Baden, Wurtemberg, and Frankfort,	500	200

According to the work of Baron Von Reden, the entire system of Germanic lines, when completed, will consist of 7600 British miles.

The capital which will be absorbed by this vast net-work of railways is estimated at £74,793,600 = $3,054,801,024. Average cost per mile £10,000 = $48,400. The average of those already constructed, £8,000 = $38,720.

It is announced that in 1844, eight millions of labourers were employed on the German railways.

In the whole of Germany there were in operation or in progress, 1st January, 1846, 43 railroads, whose length was 3565 English miles, in the aggregate.

Manufactures in the Zollverein.

The manufacturers of Germany are nearly all established on the Rhine, and in the immediate vicinity of the coal mines of Westphalia, Saxony, and Silesia, and never use, or in any way are dependent upon, English coal.†

Manufacture of natural Steel.—Germany possesses three important deposits of sparry minerals, adapted to the fabrication of steel. Two of these are included within the Zollverein. The one, situated in the Duchy of Nassau and the Siegen country; the other in Thuringia. The third, belonging to Austria, occurs in Styria, Carinthia, and the Tyrol.

The Zollverein produces annually about 8000 tons, and Austria about 13,000 tons.‡

The treatment in the high furnaces is as sollows. The ordinary mixture of the charge is thus:

74 per cent. of roasted mineral,
20 per cent. mineral not roasted,
6 per cent. of manganese.

100

To which is added 5 per cent of limestone.

Nearly all these furnaces operate with wood; but at Siegen they have

* Association Allemande, Faits commerciaux, No. 241, 1845.
† Observations on the exportation of coals. London, 1842, p. 12.
‡ Rapport sur l'exposition de Berlin. Paris, 1845, pp. 166, 207.

experimented with coke, which has conducted to similar results as those with wood, the quality being the same.

Cutlery.—The principal centre of fabrication is at Solingen and its environs, where within a small area are supported 30,000 persons,—a population of experienced workmen. No branch of manufacture is more varied than that of cutlery, or is divided and subdivided into such an infinity of forms and dimensions, and prices. The manufactures of Solingen comprise, for instance, 1000 sorts of table knives, 5000 varieties of scissors, 2000 varieties of knives and pen-knives.

IRON MANUFACTURE IN THE COUNTRIES OF THE ZOLLVEREIN.

The refineries are frequently at a distance from the high furnaces, from the want of water or of coal; and it is no exaggeration to estimate the mean cost of conveyance from one of these establishments to the other, as high as ten shillings the two hundred weight, or £5 the ton.

The price of coals, at the pit's mouth, is much higher in Germany than in England; as may be seen by the following comparative statement:

				Per English Tons.		
				s.	*d*	
Westphalia,	90 centimes, =9*d*.	the 100 killog. or 2 cwts.	English,	7	7 =	$1.83
Saarbrücke coal,	1.6 to 1.8	do.	for the forges of the Moselle,	15	0 =	3.63
England,	5½ to 7*d*.	do.	for the principal forges,	5	0 =	1.21

In the opinion of the forge masters of Germany, these are the principal causes why English iron can be sold at 12*s*. the metrical quintal [100 kilogrammes] equivalent to £6 per English ton below the prices of Germany. These arguments are combated by the manufacturers of hardware, by reasons equally plausible. They say, that the iron for which they pay, in the latter country, 430 francs, would only cost coming from England, at Düsseldorf, 280 francs. The difference, to the loss of the German manufacturer, being 150 francs, and in estimating the daily consumption, by twenty workmen, at 150 kilogrammes,=330 lbs. English, it gives a loss of 22 fr. 50 c., or 18*s*. English. This, if we count the whole consumption, forms an enormous sum.

Finally, they accuse the forge masters of unnecessary high prices for their iron. According to the artisans, the former make too large gains; or their establishments are badly conducted or badly constructed; for, when in Belgium the 100 kilogrammes of cast pig cost 120 francs; the bar iron, for nails, cost 250 francs; leaving for their fabrication, 130 francs. The pig iron of Westphalia cost 150 francs; the bar iron, for nails, pays 350 francs; giving for the fabrication 200 francs, or 70 francs more than in Belgium.

After duly investigating the condition of the Westphalian, Silesian, and Rhenish iron works, the authors of the report of 1845, remark that the German forges, wherever they be, have good need of organization, to maintain themselves, either against the English competition or that of Belgium; for the success of the English iron masters has conducted them to immense fortunes, and have enabled them to establish gigantic works; such, for instance, as that of Dowlais, in South Wales, which alone furnishes about the fourth part as much iron as all the product of the Zollverein. If such establishments could dispose to advantage of the three-fourths of their production, they could afford to sell without profit the remaining fourth, and cause an immense loss to their competitors on the continent.

M. Goldenberg observes that *in France*, since 1824, the quantity of iron

made by wood fuel, has decreased at least twenty per cent. In Germany the same decrease has taken place; but they have not been able to substitute coal-made iron. Consequently, there is a large increase in the demand there for English iron.*

Mean price [in 1845,] of grey pig iron in the Zollverein. Made with coke, 8½ francs per 100 kilogrammes,=£3 10s. per English ton,=$16.94; with wood, 12 francs per do.=£5 per do.=$24.20. Mean price in France—with coke, 13 francs per do.=£5 9s. per do.=$26.37; with charcoal, 17 francs per do.=£7 per do.=$33.88; English iron, at the frontier of Prussia, after paying the duties, 10 francs to 11½ francs per do.=£4 3s. to £4 16s per do.=$23.23.

Kingdom of Prussia.—See under the head of Prussia.†

Kingdom of Bavaria.—All the pig iron of this country is produced with wood as fuel, and the refining is generally effected by means of the same combustible. In the Maine, they puddle the iron both with wood and with turf, while in the circle of the Rhine coal is employed. There appear to be a number of iron works in this country, but they produce but a very small annual amount, each, and they only are in operation during a portion of the year. Karsten gives their total number at seventy-one, and the production only 9000 tons, yearly. Hasse estimates it at rather more; viz. at 12,000 to 15,000 tons.

Kingdom of Wurtemberg.—Great efforts are being made here to perfect the fabrication of iron, and to economize the combustible. Numerous trials have been made by M. Faber Dufaur, to employ gas in the high furnaces. Wood charcoal is used for founding and refining at Wurtemberg. At Wasseralfingen and Kœnigsbrunn, puddling by the aid of gas, of turf, and of wood is conducted.

According to Karsten, all the works of this country are comprised in six high furnaces, twenty-four refining furnaces, and some few puddling furnaces, forges, and rolling-mills. The production is only 4,500 tons of pig iron, and 2,200 tons of converted iron, yearly. For details respecting the use of peat in the iron works, see Wurtemberg.

Kingdom of Saxony.—There existed in Saxony, in 1840, sixteen, and in 1841, eighteen high furnaces, all using wood. Two others were in construction, where coke was the fuel. In 1845, there were sixteen high furnaces, fifteen cupola furnaces, fifty refineries, and several other establishments, employing twenty great forges, 4,500 workmen, and supporting 15,000 persons. The value of the production was £166,599.

Production and fabrication of iron from 1837 to 1845:

	Cast metal.	Forged, &c.	Total.
In 1837,	7,290 tons.	2,540 tons.	9,830 tons.
" 1840,	6,307 "		
" 1841,	7,760 "	2.570 "	10,330 "
" 1845,	15,000 "	4,000 "	19,000 "

Wood abounds in this country, but coal is also mined in the environs of Zwickau and Dresden; and the iron establishments have the privilege of procuring their wood coke from the State forests.

* Rapport par M. Goldenberg, February, 1845; Documens sur le Commerce Extérieur, No. 241; Association Allemande, p. 165.

† Traité de la fabrication de la fonte et du fer, p. 1292. Association Allemande Mouvement Commercial, 1845.

Grand Duchy of Baden.—Of late years great progress has been made in the manufacture of iron, principally as relates to the employment of the heat, which was previously lost in the high and refining furnaces. Nearly all the furnaces are now supplied with the hot-air blast.

In 1841, there were seven high furnaces, all situated in the south, and fifty-four refinery forges. Part of the foundry iron is converted into castings of the first and second fusion; the rest is generally refined with wood.

The quantity of pig iron averages about 6,200 tons annually. Converted iron, chiefly for exportation to Switzerland, 4,200 tons.

Grand Duchy of Hesse-Darmstadt.—Contains only five high furnaces; all using wood, and producing about 4,000 tons of pig metal. In this country lignite is found, but not true coal.

Thuringian States.—Chiefly the duchy of Saxe-Meiningen, and the principalities of Schwarzbourg, Rudolstadt, and Reuss, produce the most iron, by means of wood. The production was estimated, in 1841, at 3,700 tons per annum.

Electorate of Hesse.—Possesses eleven high furnaces, of very feeble power, producing only about 2,600 tons yearly. They employ hot-air, and experiments have been made in relation to the use of gas in the high furnaces. They convert about 1,200 tons yearly.

Duchy of Nassau.—All the iron made in this duchy is by means of charcoal. There are nineteen high furnaces, producing yearly, 7,500 tons, which are chiefly converted and employed in the country. Lignite, when coked, is used in some of the processes: this combustible is remarkable for its purity.

Duchy of Brunswick.—The high furnaces, to the number of ten, employ charcoal, and produce about 2,800 tons of cast iron; of which about one-third is converted into various uses.

The *Principalities of Anhault, Hohenzollern, Waldeck,* and *Hesse-Hombourg,* altogether only furnish about 1,800 tons of pig iron, annually.

The following table of the production of iron, at various periods, in the Zollverein, is furnished by the authors of the "*Traité de la fabrication de la fonte et du fer,*" to which table, we have added the population of the states of the Zollverein.

States of the Zollverein.	Years.	Pig Iron. Tons.	Converted Iron. Tons.	Population of the States of the Zollverein—1838.
Prussia,	1841	87,540	79,100	14,319,710
Saxe Royale,	1841	5,550	2,160	1,665,590
Wurtembourg,	1839	5,840	3,090	1,646,780
Bavaria,	1832	12,550	6,030	4,338,370
Baden,	1839	8,000	5,000	1,227,260
Hesse Darmstadt.	1835	3,600	2,420	793,130
Electorate of Hesse,	1841	3,090	1,430	721,550
Nassau,	1841	17,500	2,100	387,570
Thuringian States,		4,230	2,850	1,051,950
Brunswick,	1839	4,120	2,110	269,000
Luxemberg,		2,060	1,180	184,760
Anhault,		720	330	61,480
Hohenzollen,		510	270	63,190
Waldeck,		430	230	56,480
Hesse Hombourg,				33,400
Frankfort,		260	140	64,570
		156,000	108,440	26,884,790
Mechlenbourg Schwerin, since added,				478,800

Population in 1843, 27,623,818; in 1845, 28,548,553.

In 1841, the Prussian provinces produced and manufactured, 229,579 tons of iron. In 1845, the Zollverein consumed 300,000 tons.

The following table shows the periodical amount of iron imported into the states of the Zollverein :—

Years.	Pig iron. Tons.	Bar iron. Tons.	Total.
1836,	9,500	17,200	26,700
1837,	15,300	15,600	30,900
1838,	27,700	37,500	65,200
1839,	30,000	33,700	63,700
1840,	59,000	43,300	102,300
1841,	98,500	55,000	153,500

PRUSSIA.

Coal Statistics.—With a view to show the annually increasing production of fossil fuel, in this country, we have brought together the materials which are arranged below. They exhibit the amount of stone coal and Braunkohlen or Lignite, raised in the Royal and private mines of Prussia, in metrical tons of 2207 lbs.

Table of Production in Prussia.

Rates of increase.	Coal and Anthracite annually raised in the Prussian Provinces.					Lignite or brown coal.	Total value of coal and Lignite.	Aggregate of coal and Lignite.
Years.	Silesia. Tons.	Prussian Saxony. Tons.	Westphalia. Tons.	Rhenish Provinces. Saarbruck. Tons.	Total Coal. Tons.	English Tons.	Sterling.	Tons.
1814 to 1819	285,621	9,445	370,268	233,191	898,525			
to 1824	555,604	11,925	365,844	284,728	1,218,101			
to 1829	460,529	14,170	522,280	370,567	1,367,546			
1832	460,155	16,278	475,158	342,244	1,299,835			
1833	485,618	15,532	760,953	389,016	1,651,119			
1834	482,005	13,596	765,777	401,760	1,663,138			
1835	497,845	13,681	775,778	424,336	1,711,640	467,646		2,179,286
1836	558,945	13,188	745,071	492,143	1,809,347			
1837					2,078,696	522,526	603,931	2,601,222
1838					2,308,368	613,933	693,150	2,922,301
1839	715,350	17,328	1,006,991	702,963	2,442,632	649,412	768,260	3,092,044
1840	847,733	17,491	990,352	694,960	2,550,536	695,071	793,860	3,246,607
1844	850,000		1,200,000	700,000	2,750,000		909,000	
1845					2,750,000			

Hence will be perceived the rapid increase in the production of these mineral combustibles. The mean annual increase of coal from 1819 to

1829, has, therefore, been 42,636 tons, or an advance of 52 per cent. in eleven years. From 1832 to 1844 there was an average annual advance of 120,847 tons; amounting to an increase of 111 per cent. in twelve years.

The annual increase during the entire 25 years, from 1819 to 1844, has been, 74,000 tons; and from 1819 to 1846 there has been an advance of 175 per cent. in that period, or, including lignite, 261 per cent.: which lignite is chiefly consumed in the province.*

Number of workmen employed in the stone coal mines, and exclusive of lignite. In 1839, 19,370; in 1840, 21,149; in 1844, 25,000.

Prussia is divided into five mining districts, viz. Brandenbourg, Silesia, the province of Saxony, Westphalia, and the Duchy of the Bas Rhin.

General Production in 1840.

The following table, for the year 1840, shows the details of mines of *coal, lignite, and asphalt* in these districts. They comprise near two thirds of the entire value of mineral production in the kingdom.

Mineral Combustibles.	No. of mines.	Production.		No. of workmen.	Persons who compose their families.	Value at the place of extraction.		
		Metrical Tons.	Average price. Francs.			Francs.	£ Sterl.	U. S. dollars.
Coal,	535	2,550,536	7.17	21,149	50,051	18,293,672		
Lig'te,	217	695,071	2.00	2,860	6,974	1,394,032		
Aspha.	1	33	3.65	15	69	12,057		
Total,	753	3,245,640		24,024	57,094	19,699,761	788,000	3,822,000

Details of Production in 1840.

The proportions of *coal and lignite* furnished by each Prussian district, in the same year, 1840, are the following; premising that the district of Brandenburg has, until very lately, been supposed not to contain either of these mineral combustibles, and is not included in this return.

Districts. 1840.	Coal and anthracite.		Lignite.		Total of combustible.	
	Number of mines.	Tons produced.	Number of mines.	Tons produced.	No. of mines.	Production in Tons.
Silesia,	271	847,733	2	145	273	847,878
Saxony,	3	17,491	149	460,475	152	477,966
Westphalia,	220	990,352			220	990,352
Lower Rhine,	41	694,960	66	234,451	107	929,411
Total,	535	2,550,536	217	695,071	752	3,245,607

* Authorities. Bulletin de la Société d'Encouragement, tome XXXIX. p. 35. Annales des Mines, tome XVII. p. 547. Mining Journal of London, Vol. XI. p. 107, Vol. XII. p. 90. Bulletin de la Commission centrale de Statistique, Royaume de Belgique, 1843.

The Prussian ton of coals weighs 4 quintals or centzners, of about 110 lbs. each; therefore there are rather more than 5 Prussian tons to 1 English ton. The measure called a Scheffel is a fraction less than 1¼ Imperial English bushel.

The Prussian quintal is about 113 lbs. English, or about 20 to the ton Engl.
The French Metrical quintal 220 lbs. " " 10,146 to the ton Engl.
The Zollverein tonne is 1000 kilogrammes.
The English ton is 10.146 kilogrammes = 2240 lbs.
The French Metrical ton is 2207 lbs.

Details of Production in the four coal districts, from 1814 *to* 1845.

The following table relates, more particularly, to the annual amount and value produced of *coal and lignite,* in the thirty years preceding 1845, in the four coal districts.

Periods.	Coal and Anthracite.		Lignite or Braunkohlen.		Total of combustible.	
	English Tons.	Value in Francs.	English Tons.	Value in Francs.	English Tons	Value in Francs.
1814 to 1819	898,525					
1819 to 1824	1,218,100					
1824 to 1829	1,367,546					
1829 to 1834	1,664,902					
1836	1,800 000					
1837	2,078,696	13,928,716	522,526	1,046,131	2,601,222	14,974,847
1838	2,308,368	15,949,200	613,933	1,240,806	2,922,301	17,190,006
1839	2,442,632	17,742,420	649,412	1,310,372	3,092,044	19,052,792
1840	2,550,536	18,293,672	695,071	1,394,032	3,245,607	19,687,704
1844	2,750,000				about 3,650,000	22,500,000

For notices of importations and exportations from Prussia, see Prussia proper.

			The metrical ton.
The price of coals at the pit's mouth,	in 1837,	averages 5s. 6d.	=$1.33
" " "	in 1840,	" 7 fr. 17 cts.	=$1.39
" of lignite "	"	" 2 fr.	=$0 39
" of coal "	in 1842;	" 5s. 6d.	=$1.33

As may be seen by a previous table, the provinces of Silesia, Westphalia, and the Rhine have, since 1819, been rapidly advancing in their production of coal. Thus, while the first half, or eleven years increased at the rate of more than forty-two thousand tons per annum, the second eleven years advanced at above ninety-eight thousand tons per annum.

The supply from the province of Saxony is not important, and its quality is inferior.

Prices of Coal.

The average price of all the coal of the Prussian mines, at the pit or place of extraction, was,

Coal.				Lignite.
Years.	Francs.*	Sterling.	U. S. currency.	Francs.
1819	6.80	5s. 6d. per ton.	$1.32	
1837	6.70	5 5 "	1.30	2.00
1838†	6.91	5 7 "	1.34	2.01
1839	7.25	6 1½ "	1.46	2.01
1840	7.17	6 2 nearly	1.48	2.00
1844	6.85	5 6½	1.33	2.00

* Mean price in 1819, 2¼ silbergros, = 1.198d. per quintal, = 5s. 6d. per ton.
" " from 1832 to 1837, 5s. 6d. per ton.

† It will be perceived, on comparing the official returns of the coal producing countries, that a material difference exists in the respective prices of the mineral combustibles.

In 1838,
- Prussia, coal and anthracite, 6.91 fr. per ton. Lignite, 2.01 fr.
- France, coal, 9.70 " " Anthracite, 14 fr. " 9.13 "
- Belgium, coal, 13.93

See the details in those countries.

Since the organization of the Germanic Union or Zollverien, the Prussian and German manufactures have received so strong an impulse and progression, that the consumption of coal has been correspondingly increased, and, of consequence, it has encouraged the application of more capital and industry to the opening and working of mines. Yet it has been remarked that, during the lapse of those twenty-five years of our table, the price of coal has remained the same, within a very trifling variation, say from six to twelve per cent.

In the meanwhile the increase in the price of wood, although varying according to the different provinces, has considerably advanced; probably at the rate of fifty per cent. within the same period. Thus, the iron and other metallurgic operations which require much fuel, can only exist and prosper in the vicinity of the coal mines, and there only where the means of transport are convenient and economical.

Since 1830, coal mining enterprise having been favoured by the increased facilities of carriage upon the Roër and the Rhine, large quantities of coal have been despatched to Holland from the provinces of Westphalia and the Rhine, and particularly from the district of Trèves to France, Bavaria, and the Grand Duchy of Baden. The export from Silesia to Cracow and the Austrian states is unimportant. The countries somewhat distant from the Prussian coal mines prefer to supply themselves with English coal, which can be imported at low rates of freight, into Stettin and other Baltic ports. Pomerania, Brandenburg, and Prussian Saxony are thus situated.*

Number of Mines and Miners in the Prussian Collieries.

The mines of Coal in Prussia gave employment and support to the following persons, exclusive of those engaged in mining brown coal.

Years.	Concessions.	Pits in work.	Miners.	Their families.	Total. Persons.
1837	331		16,218	59,747	75,965
1838	339	628	17,884	42,237	60,121
1839	364	651	19,370	44,710	63,540
1840	535		21,149	50,051	71,200
1844	540		25,000	75,000	100,000

PRUSSIAN PROVINCE OF BRANDENBOURG.

Peat occurs in all the Prussian provinces, but especially in Brandenbourg. Nature appears to have endeavoured in some degree to compensate for the want of coal, by the abundant supply of turf.

Bituminous coal discovered of late years.

Berlin.

Large seams of coal have been discovered, in 1841, at Buckaw, a small village not far from Berlin. This coal promises to be so abundant, that manufacturers and steam engines will probably soon be supplied with coal at half its present price. When it is known that the Berlin manufactories employ about forty thousand workmen, the importance of this discovery will be easily understood.†

Heretofore the English coal has had the advantage at Berlin over that of Silesia and Saxony, but beyond Berlin English coal cannot penetrate.

* Mining Journal, March 19th, 1842. † German paper.

Peat is sold at Berlin under the name of "*tourbe de linum.*" It is of good quality, often compact and hard, and in that case no vegetable fibres appear; but it is composed of the cellular tissue of plants which have been compressed into exceeding thin laminæ.*

PRUSSIAN SILESIA.

True Coal formation.—The principal coal area here stretches for a distance of seventeen leagues, terminating in Bohemia, where we have given a short notice of it from M. Chevalier. In some of the rich bituminous coal mines of Silesia, occur portions which seem almost incombustible, and are supposed to be anthracite.

In this country are vast deposits of valuable fuel; and many years ago there were more than a hundred mines in operation.

Production of the Coal Mines of Silesia, from the Official Returns.

Years.	Prussian tons.	English tons, nearly.	Years.	Prussian tons.	English tons, nearly.
1819	1,428,107	285,621	1837	2,100,356	420,071
1824	2,778,020	555,604	1838	2,281,773	456,334
1829	2,302,645	460,529	1839	3,576,750	715,350
1832		466,155	1840		847,733
1834	2,416,033	482,005	1841	2,968,311	593,662
1835	2,489,228	497,845	1842	3,124,621	624,924
1836	1,815,556	363,111	1844		800,000

The weight of Silesia coal is about eighty-two kilogrammes the hectolitre, which is equivalent to 12.39 hectolitres the ton, English, and to 35.16 bushels to the ton. At Dietrichhütte, however, it is heavier, being 87.78 kilogrammes to the hectolitre, which is 11.58 heclolitres and 32.86 bushels to the English ton.

Coal and iron operations are more especially carried on with vigour in the Regency of Oppeln, where, in 1843, there were fourteen high furnaces and one hundred and six other iron works.

South of Breslau, a coal basin,

Near Schweidnitz, and in the vicinity of Neisse, Glatz, &c., coal is worked.

At Neurod and Waldenburg are rich deposits of coal.

The main coal-field of Silesia extends from Schatzlar, on the Riesengebirge, on the one side, to the Lordship of Nachod, in Bohemia, on the other,† and is of very good quality: but it is comparatively inferior to the coals of the Saar.

The working of coal has been carried to but slight depth in Silesia;—the beds which are in work are far from numerous, but they are of considerable thickness. The two seams at Kœnigshütte are, respectively, twenty and a half feet and ten and a quarter feet thick. The collieries of Maria and Caroline, which supply Hohenlohehütte, have two beds of upwards of twenty feet. Those exposed in other collieries have about the same power.

In general, the coal of Upper Silesia is meagre.

The coals of Silesia are exported to Cracow and the Austrian states, but in unimportant amount until of late.

The price is much lower than in the Sarrebrück basin: the best coal

* M. Link, on the Microscopic Observation of Turf, Lignite and Coal.
† Sternberg, Flora der Volwelt.

being from six to eight francs per metrical ton, and the inferior only from two to three francs, in 1844.*

In 1841 the average price at the pit's mouth, in Upper Silesia, was 4.50 francs, = 4*s.* 6*d.*, = $1.00 per ton.

Fire in the Coal Mines.—A coal mine in the neighbourhood of Kœnigshütte, in Silesia, has been on fire for twenty years past, but, until recently, has occasioned no alarm. It has of late assumed an alarming character, shooting out immense volumes of flame, which threaten destruction to the surrounding buildings, and to the vast forests of the country. A steam engine has been established for the purpose of discharging water into the mines, but without producing the slightest effect.†

PROVINCE OF PRUSSIAN SAXONY.

This province produces very little black or true mineral coal, of good quality; but, as some compensation, it affords a large quantity of lignite, *Braunkohlen*, or brown coal. This, of course, is much inferior to the true coal, being neither so hard nor so capable of furnishing heat; consequently is of less value.

It is estimated as holding a middle rank, between mineral coal and peat; and is chiefly consumed within the province itself, and within a limited range of the places of extraction.‡

The district where coal operations are carried on with most activity, is that of Merseburg.

Prussian Saxony, as far back as 1837, furnished annually upwards of a million and half of bushels or scheffels of coal, or about 135,000 metrical tons.

At Witten, [Wittenburg] north of Halle, in Prussian Saxony, on the Elbe, a coal formation exists; but the only application of pit-coal, heretofore, in this vicinity, is in the salt-works.§

On the north-east and south-west of the Hartz mountains, near Ballenstadt and Neustadt, coal measures repose on the transition rocks of that group.

Production.—	1819	9,445	English tons.
	1829	14,170	"
	1834	13,596	"
	1840	17,491	"

Iron-works.—Saxony had in operation in 1844, one hundred and nine furnaces, refineries and forges, besides many establishments for working iron, employing 4,500 workmen, and supporting 15,000 persons. Also thirty establishments for the construction of machinery, employing 1,500 workmen, and supporting 4,000 persons. Value of the production of all these, 7,875,000 francs.||

Peat, or rather the gas obtained therefrom, has been successfully employed in iron and puddled steel making, at the furnace of Magdesprung, in the Hartz mountains.¶

Amber is found in the neighbourhood of Prietz and Wittenburg, in Prussian Saxony, in a bituminous clay, mixed with lignite.**

* Mouvement Commercial, 1845. † Mining Journal, 8th April, 1843.
‡ Mining Journal, Vol. XII. p. 90. § McCulloch, Wittenberg.
|| Documents sur le Commerce extérieur, No. 241. Paris, 1845.
¶ Mining Journal, March 7, 1846, from Report of M. Goldenberg.
** Dr. Ure's Dictionary of Arts, &c. p. 47, American edition.

PROVINCE OF WESTPHALIA IN WESTERN PRUSSIA.

Two coal-fields were described by Professor Sedgewick and Mr. Murchison, in 1840.

The first, or productive coal-field, near the right bank of the Rhine, possesses common characters with the English coal-fields. It is affected by many anticlinal and synclinal lines, which have thrown the productive portions into a number of irregular troughs, ranging in the direction of the strike, east north-east.

The lower, or unproductive coal-field, contains only thin seams of coal, and impressions of plants, included in carboniferous sandstones and coarse grits of great thickness.

In the opinion of the above named geologists, this lower or unproductive division of the coal-field, is lithologically almost identical with the great culm field of Devon, and resembles it also in its numerous impressions of small plants. It is the *Flötzlehrer Sandstein* of the German geologists, and had been regarded by them as the highest member of the greywacke or selurian series; but in Von Dechen's map it is placed on the parallel of the millstone grit of England.*

The surplus coal of Westphalia is distributed in the neighbouring countries. That of the Rhenish provinces, and particularly of the Regency of Treves, not consumed in manufacturing operations, is transported to France, Bavaria, Hesse, and Baden. Large quantities of coal are sent to Holland, from Westphalia and the Rhine. The district of Treves supplies coal to France, and Baden. Coal operations within this province are carried on with the greatest activity in the district of Arnsberg.

Production of the Coal Mines of Westphalia.

Years.	Prussian Tons.	English Tons nearly.
1819	1,851,341	370,268
1824	1,829,222	365,844
1829	2,611,402	522,280
1832		475,158
1834	3,831,693	765,777
1835	3,878,891	775,778
1839	5,034,958	1,006,991
1840		990,352
1844		1,000,000

At the Buckeburg lignite beds are worked.

RHENISH WESTPHALIA.

Bituminous and silicified wood near Siegen.—In 1837, there were discovered, in the neighbourhood of Hoher-Seelbachs-Kopf, two miles from Siegen, several trunks of fossil trees, in a basaltic turf, or conglomerate; and, in 1839, the Prussian government ordered the royal administration of mines at Bonn, to make examinations into this interesting matter, on a large scale.

It was ascertained that this position was 1596 French feet above the level of the sea, while the most elevated point of the basalt was 2,021 feet.

In the progress of this investigation, it was seen that the basaltic conglo-

* Proceedings of the Geological Society of London, Vol. III. p. 301.

merate contained bituminous wood, of a fibrous texture and frequently of a silky lustre. In the same conglomerate was also discovered silicified wood; placed for the most part upright, according to the direction of the fibres. They are commonly long fragments of trunks of trees; sometimes of the length of fifteen feet; and generally of a white colour.

Specimens of these fossil trees were placed in the hands of M. Göppert, of Breslau, a savant well-versed in the knowledge of petrified vegetables. He reported that both the bituminous and silicified wood or lignite belonged to the family of the coniferas, of the genus Pine; but of species which are essentially distinct.

The same bituminous wood occurs in the lignites at Friesdorf, near Bonn, and at Salzhausen in Wetteravia. This species having much analogy, in its anatomical structure, with the *Pinus larix*, or Larch of the living vegetation, has received from M. Göppert the name of *Pinites proto-larix.*

GRAND DUCHY OF THE RHINE.—RHENISH PROVINCE BELONGING TO PRUSSIA.

Coal Basin of Saarbrück or of the Sarre.—According to Messrs. Elie de Beaumont and Dufrénoy, this great coal-field extends, along the southern foot of the chain of the Hundsruck, from north-east to south-west, over twenty-five leagues long by from four to seven leagues in breadth.

This formation, like those in the interior of the Vosges, is deposited in a depression, surrounded by transition mountains and others of the *grès de Vosges.** Messrs. Sedgewick and Murchison have shown that, as relates to the geological age of the coal formation of the Rhenish provinces of Westphalia, of Belgium, and the countries bordering on the Rhine, in lithological character and fossil contents, it is undistinguishable from the coal-fields of England. The lowest division of these coal measures is affirmed to be almost identical with the great culm field of Devon, and possesses an exact agreement in the abundant impressions of small-plants.

The leading object of the visit of these gentlemen to these provinces, was to ascertain whether, in any of them there exists a group of strata with the Devonian fossils, in a position intermediate between the carboniferous and silurian systems, and thus to establish the existence of the Devonian system. This fact was satisfactorily proved.†

The districts in the Rhenish provinces of Prussia, where the *exploitation* of mines is most vigorously pursued, are those of Treves, Aix-la-Chapelle, and Dusseldorf.

Heretofore, the coal beds are only remarkable in two districts, which have been named, the one the basin of La Glane, and the other the basin of the Sarre.

Sub-basin of the Glane.—This basin is very poor in combustible: the coal beds are almost always covered by a foreign substance of a smutty yellow or dark brown colour, which matter is sometimes divided into two beds, and often incloses sulphuret of zinc. The coal is generally dry and of bad quality, and serves principally for burning the lime with which it is found mixed.

Sub-basin of the Sarre, or of Sarrebrück.—This district is infinitely more rich than the preceding. At Duttweiler are known thirty-two coal beds; and in the entire basin they do not count less than 103 beds, whose

* Explication de la Carte geologique en France.
† Proceedings of the Geological Society of London, May, 1840.

thickness varies from eighteen inches to thirteen feet. The *exploitation* is only carried on in thirty adjoining beds, of which the principal one, of fifteen feet thick, is known from Sarrebrück even to Neukirchen.

M. Humboldt states that in this coal-field there are one hundred and twenty seams of coal, exclusive of a host of smaller seams, less than a foot in thickness.* It is calculated that, in continuing the present annual extraction, the basin of Sarrebrück can still furnish a supply for sixty thousand years.†

Basin of Sarrebruck, or Saarbrück.

Depth of the Coal Basin.—In a communication to the celebrated Von Humboldt, the excellent geologist, M. Von Dechen, observes, that "the depth of the coal measures at Mont St. Gilles, Liege, I have estimated at 3650 feet below the surface, and 3250 feet below the sea level. The coal basin at Mons lies fully 1750 feet deeper.‡ These depressions, however, are trifling, when compared with that of the coal strata of the Sdar river, [Saarbrück.] After repeated trials, I have found that the lowest coal strata known in the county of Duttweiler, near Bettingen, north-eastward from Saar-louis, dip 19,406 feet, and 20,656 feet under the level of the sea." This conclusion exceeds by 8000 feet the estimate which I have given in the text of Cosmos, for the basin of Devonian strata. These Belgian coal measures, therefore, lie as far below the level of the sea as Chimborazo rises above it; at a depth where the temperature of the earth must be 435° F.§

Lower Rhine.—Sarrebrück Coal.

Prices, &c., of Coal—Saarbrücken.—Stein kohl, or stone coal,—1 foudre=30 centners of 110 lbs. cost at the mine 3 thal. 24 gros.; freight and all charges, delivered at Coblentz, 4 thal. Price at Coblentz or Niewid, 7 thal. 24 gros.=22*s.* 4*d.* English, which is equal to 15*s.* 2*d.*=$3.64 per ton. Deducting from 22*s* 4*d.* the discount of 15 per cent. is net 18*s.* 11*d.* Further transportation to iron works at Hachenburg, 27 miles, 8*s.* 4*d.*; total, 27*s.* 3*d.*=per ton 18*s.* 3*d.*=$4.42. Price of Prussian coal, delivered at Sarrebrück, in 1846, 6*s.* 8*d.*=$1.60 per 2000 lbs.

Stone Coal at Bingart.—The price, delivered at the mine, is, for 30 centners=10 florins=16*s.* 8*d.*, which is at the rate of 11*s.*=$2.64 per ton. In 1789, the tariff on the importations of Sarrebrück coal by France, was 16*c.* In 1815, 11*c.*

The cost of the Rhine steam coal, at Dusseldorf and Cologne, was recently about 24*s.* per ton=$5.82.

The forges of the Moselle pay for the coal of the Saar from 1*fr.* 80*c.* to 2*fr.* the 100 kilogrammes, which is equivalent to from 14*s.* 6*d.* to 16*s.*= from $3.50 to $4.00 per English ton.

In Westphalia the coal costs, upon the spot, 7*s.* 3*d.*=$1.75 per ton only.

In England the principal iron works are supplied at from 4*s.* 6*d.* to 5*s.* 6*d.* per ton; thus showing one great cause for the low price of iron, made in that country.

* Cosmos, par M. Alex. Von Humboldt.

† Mouvement Commercial, No. 241, 1845.

‡ The lowest coal measures in the Mons district are usually estimated to descend to the depth of 6000 feet.

§ Humboldt, Cosmos.

Production.—Table of the production of coal in the Rhenish Provinces of Prussia, according to official returns:

Years.	Prussian tons.	English tons.
1819	1,165,957	233,191
1834	1,423,642	284,728
1829	1,852,837	370,567
1832		342,244
1833		389,016
1834	2,008,800	401,760
1835	2,121,675	424,336
1839	3,514,815	702,963
1840		694,960
1844		700,000

Exportation of Coal from the Rhenish Provinces of Prussia, rendered into English tons.

To France.		To France.		To Holland.	
Years.	Chiefly from Saarbrück. Tons.	Years.	Chiefly from Saarbrück. Tons.	Years.	Chiefly from Westphalia. Tons.
1787	9,856	1840	156,300	1833	231,500
1802	17,740	1841	167,950	1834	290,500
1811	24,640	1842	169,610	1835	324,000
1820	27,500	1843	210,000	1836	365,000
1830	74,000	1844	205,000		
1833	75,938	1845	237,200		
1835	89,000	1847 11 mon's	184,636		
1838	123,410				

In the collieries of Prussia, the rules prohibit the workmen from ascending and descending the pits, in the tubs; like the Cornish and Belgian mines, the access was solely by ladders, until recently.*

Basin of the Rhine.—Brown Coal.—Dr. Hibbert has communicated the "History of the Extinct Volcanoes in the Basin of Neuwied." In the "Eifel" are thin patches of brown coal and tertiary clay. Mr. Horner is of opinion that the brown coal of the Rhine is, probably, of the age of the lacustrine limestone of Aix en Provence.†

An association has been formed, 1846, under the title of "the D'Arlincourt Prussian Zink and Coal Company," with a view of working some extensive concessions in the Prussian territories, on leases for forty-five years. One of these positions is near Dusseldorf, and consists of a rich coal-field, possessing several beds of bituminous coal, so near the surface as to render steam power unnecessary. The right of mining extends over fifteen thousand acres, and fifteen miles and a half in length, through a district studded with manufactories.‡

* Annales des Mines, 1845. † Proceedings of Geol. Society of London, Vol. I. p. 455.
‡ Mining Journal, June, 1846.

PRUSSIAN AND GERMAN PROVINCES ON THE RHINE.

The quantity of coal which descended the Rhine from Germany into the Netherlands, by Lobith.*

	Years.	Exported. Germanic† quintals of 50 kilogrammes.	Exported. Tons.	Imported. Tons.
	1841	2,738,518	136,925	636
Unusually low water	1842	2,032,274	101,610	2,475
	1843	1,689,600	84,480	

The amount by this mode of transportation is annually decreasing.

Movement of coal from the *Port of Mulhouse*, Upper Rhine.

Years.	From Prussia and Bavaria. Tons.	From France. Tons.
1841	4,740	77,199
1842	4,570	75,471

PROVINCE OF THE RHINE IN WESTERN PRUSSIA.

Environs of Bon—Brown Coal Formation—Tertiary Age.—This region has been illustrated by several eminent geologists, among the last is Mr. Horner. In many particulars this formation seems to correspond with the great tertiary coal area of North America. Like that, it is made up of numerous beds of sand, sandstone, conglomerate, clay of different qualities, and clay iron-ore, in layers and detached masses, horizontally disposed, or nearly so.

The brown coal or lignite is of several varieties, from a friable earthy substance, to jet, and wood in different stages of bituminization, burning with a bright flame. In one position a lignite is found with a thin powdery coating of *amber;* on the authority of M. Von Dechen.

Varieties of silicified wood have been also found, which on examination, are decided to be dycotyledonous. Much difficulty, of course, exists in determining the identity of this vegetation. Professor Lindley has, however, satisfied himself as to a few genera. One of these is the *cinnamon*, accompanied with the leaves of some kind of *palm*. These plants have been also found in a lignite formation at Aix, in Provence. The cinnamon is thought by Professor Lindley, to be identical with a species now inhabiting China. A species of Podocarpus, appears to resemble one now growing in the West Indies, and at Sincapore in Asia. Hence, it is inferred that, the climate of Bonn, at the period of the accumulation of these lignites, approximated to that of the northern provinces of China, and the valleys of Nepal.

Mr. Brown has stated that all the specimens of wood that he collected at Friesdorf are coniferous; which seems to point to a temperate rather than to an equinoctial climate.

With these have been collected the remains of fishes, shotts, insects,

* Documens sur le commerce exterieur; Association Allemande, Janvier, 1844. Ibid. Mars, 1845.

† The quintal of the Association is 50 kilogrammes = 110 lbs. English.

reptiles and quadrupeds; but we cannot advert to them more particularly here.

At *Putzberg* are at least six beds of lignite, which have an aggregate thickness of twenty-four and a half feet. At another place, the series amounts to thirteen and a half feet, beneath basalt, and resting on trachyte. At other positions the beds are worked to a much greater thickness.

The various mines of brown coal in the district of Brühl give occupation to about 1200 persons.

The microscopic examinations of M. Link of Berlin, in confirmation of the views of Mr. Brown, clearly show that the lignite of Bonn contains the wood of conifera.*

The lignite of *Friesdorf*, near Bonn, consists of fossil conifera of the genus pine; according to M. Göppert, professor at Breslau.†

Wolsberg, two leagues north-east of Bonn, on the right bank of the Rhine, exhibits a basaltic conglomerate, containing a great quantity of silicified wood, of a fibrous texture. With these also occur pieces of bituminous wood, recognized as belonging to the pine genus.

The price of stone coal, or true bituminous coal, at Bonn, is 23*s*. *gr*. per 400lb. = per ton 3*th*. 8*gr*. The quality of this coal is good; very similar to the best Welsh coal. Its flame is bright, and it makes excellent cokes.

Berg.—At Cologne, lignite beds are extensive. The principal deposit thirty feet thick ;‡ and here also is the locality of the pulverulent variety so valuable in painting.§ According to Mr. Horner, the wood in the brown coal formations bordering on the Rhine, is sometimes so fresh, and so little changed, that it has been used at Viernich for timbers in the mines. As affording some clue to the relative age of the brown coal formation, and the volcanic eruption of Siegberg, this geologist announces the fact of his having found bituminized wood in the basaltic tuff, identical in appearance with the wood of the brown coal beds.||

PROVINCES OF POMERANIA AND EAST PRUSSIA.

Amber with Lignite.—On the Prussian coast, and in fact in *Courland*, *Livonia*, *Pomerania*, *Denmark*, and a large portion of the Baltic coast from Memel to Dantzic, tertiary wood or lignites, and amber, are thrown up by the waves, or occur along the borders, particularly on the Prussian side.

Here shafts have been put down on the sea coast, which reach a bed of bituminous or brown coal; and from thence the amber is obtained in considerable abundance. It is used in the fabrication of ornaments, and no slight value is attached to large transparent specimens. In the Royal Museum at Berlin, there is a mass weighing eighteen pounds; and vast quantities are preserved in many of the German collections. Those specimens which contain insects, and other organic remains, are particularly valued. To the geologist and naturalist these beautifully preserved forms possess the greatest interest, from the fact that many of the species are unknown at the present day.¶

The amber in the lignite beds along the Prussian coast, is a substance of some commercial importance, in the aggregate; and there are regular mines of it.

* Annales des Mines, Vol. XVII. † Ibid. Vol. XVIII. p. 448.
‡ History of Fossil Fuel, p. 477.
§ Dr. Maculloch on lignites, Quarterly Journal of Science and the Arts, Vol. XX.
|| Trans. Geol. Soc. of London, Vol. IV., 1836. ¶ Allan's Manual of Mineralogy.

Beneath the sand and clay, which are there about twenty feet thick, is a stratum of fossil wood, forty or fifty feet thick, of a blackish brown colour. Parts of the trees thus fossilized, are impregnated with amber, which is sometimes found in stalactites, like icicles, hanging from them. The mines are worked to the depth of a hundred to a hundred and thirty feet; and from the circumstances in which the amber is found, it seems plain that it originated from vegetable juices. The large specimen referred to above, was found near the surface of the ground, in Lithuania.

About *two hundred tons of amber* are raised annually, yielding a revenue of $22,000 to the king. The portion of the coast from whence it is most abundantly taken, is eight leagues in length, extending from Pillau to beyond Polangen.

Respecting the origin of this substance, the *Bernstein* of the Germans, it is agreed that it is derived from the vegetable kingdom, from the circumstance of its occurring in beds of bituminous wood. According to M. T. Aessi, amber is a resin of the coniferæ.

M. Graffenauer, in a monograph on timber, addressed to the Strasbourg Society of the Sciences, supposes it to have originated in extinct species of trees.*

We have adverted to this substance as intimately connected with lignite deposits; and it is more appropriate here, because the shores of East Prussia furnish the largest masses in the world.†

The most interesting fact, says Dr. Ure, relative to this vegeto-mineral, is its geological position, which is very characteristic and well determined. It belongs to the plastic clay or lignite formation, between the *calcaire grossier* and the chalk. In Pomerania it belongs undoubtedly to this geological period; for the organic matters found still adhering to the amber, leave no doubt of its place in the series.

On the eastern shores of England, amber is a very common substance, and is there washed upon the beach, accompanied by jet.

The insects enclosed in amber have long excited an interest among naturalists. Certain families occur more abundantly therein than others. Thus the *hymenoptera*, having four naked membranaceous wings, as the bee and wasp; and the *diptera*, having two wings, as gnats, flies, gad-flies, &c. Then come the spider tribe; some *coleoptera*, or beetles, principally of the kinds which live on trees. The *lepidoptera* are very rare. All these insects are such as generally sit on the trunks of trees, or live in the fissures of their bark.

One important geological fact we must not omit to remember:—none of these enveloped insects, so beautifully preserved, have yet been identified with living species. But it has been observed, in general, that they resemble more the insects of warm climates, than of temperate zones.

The chief commerce in Pomeranian amber is with Turkey. A good piece, of a pound weight, fetches 50 dollars. For a mass weighing 13 pounds, $5000 were offered, and was expected by the Armenian merchants to bring from $30,000 to $40,000 at Constantinople.‡

In the spring of 1844, amber was found in extraordinary quantities, on the shores of the Baltic. At one village, Kahlberg, an amount worth 20,000 *thalers*, was gathered during some storms. The principal depository of amber in Pomerania is along the long narrow tongue of land, between the bay or lake of Carische Haff and the Baltic.

* Mining Review. Vol. VII. p. 388. † Allan's Manual of Mineralogy, p. 289.
‡ Ure's Dictionary of Arts.

Official value of the amber exported by land from the port of *Däntzick** in 1842, 725,000 francs, = £29,220 sterling, = $140,300. In 1843, 680,000 francs, = £27,200 sterling, = $130,700.

Professor Göeppert's researches inform us that all the Baltic amber is derived from coniferous trees, which approach to our white and red pine timber, but still constitute a particular species. The amber tree of the former world [*pinnites succifer*] had a richness in resin with which none of the coniferous tribes of the present world will bear comparison, in as much as great masses of amber are contained not only within and upon the bark, but also between the rings of the wood, and in the direction of the medullary rays, which, as well as the cells, are seen under the microscope to be filled with ambreous resin of a whiter or yellower colour in different places.

Amongst the vegetable matters inclosed in amber, we find both male and female flowers of indigenous, acicular-leaved, and cupuliferous trees; but several other species indicate a vegetation which is different from that of the present coasts and plains of the Baltic sea.†

In the valuable report of M. Goldenberg to the minister of agriculture and commerce of France, on the products of German industry within the limits of the Zollverein, the author observes, "I cannot terminate this article without citing the beautiful works in amber, opaque, white, and yellow, that some artists of Dantzick forwarded to the exhibition at Berlin, in August, 1844, and of which there are several specimens that inclose antediluvian insects."‡

Since the foregoing notes were transcribed, we have read Prof. Göeppert's short memoir on fossil amber, and on the organic remains found in it. He is of opinion that amber was chiefly formed during the period of the Molasse. The forests in which the trees grew whence this substance was derived, were situated in the south-eastern part of what is now the bed of the Baltic. With the commencement of the diluvial period, this forest was gradually destroyed, and the amber was thus drifted to the south and south-west, on the coasts and in the countries where we now find it.

Among the fragments of vegetable matter contained in this substance, those of dicotyledonous trees are chiefly abundant, and the tribe of *Coniferæ* no doubt occupied a great part of the amber forest. Of pines there are at least four species, associated with many others, [five genera.] Of leaf-bearing trees, we find five genera; and of underwood, *Ericaceæ, &c.*, forming in the whole a flora comprising forty-eight species, which has considerable resemblance to that of North America. There was also a cryptogamous flora.

The fauna of this period was extremely numerous, upwards of *eight hundred* species of insects having been discovered, besides the remains of *Crustacea, Myriapoda, Arachnidea, &c.* Only a few hairs and feathers of mammalia and birds have been discovered, and none of amphibia and fishes.

All these remains, both of vegetables and animals, exhibit only a generic identity with existing plants and animals, and are not specifically the same. The most nearly allied forms occur most frequently in North America. Several of the species exhibit, however, no analogies with known forms.§

* Faits Commerciaux, 1843, 1844.
† Cosmos, Alex. Von Humboldt.
‡ Association Allemande—Rapports sur l'exposition de Berlin, Feb. and March, 1845.
§ Quarterly Journal Geol. Soc. London, May, 1846, p. 102.

NORTHERN AND EASTERN PROVINCES OF PRUSSIA.

PRUSSIA PROPER.

The insufficiency of cheap and easy modes of communication has heretofore prevented the provinces of East Prussia, of Pomerania, Brandenbourg, and Prussian Saxony from fully providing their supplies of bituminous coal from the national mines. Consequently, they have been obliged to use English coals and coke, which reach them through Stettin, in Pomerania, and other ports of the Baltic, at high prices.* Of late, however, a certain amount of coal is said to reach the Baltic ports from the southern and western provinces of Prussia. The following statement shows the growth of this foreign coal importation.

Annual Importation of Coal from Great Britain into Prussian ports.†

Years.	Tons.	Years.	Tons.	Years.	Tons.
1831	15,956	1836	43,560	1841	116,296
1832	27,561	1837	49,925	1842	
1833	24,068	1838	60,401	1843	148,197
1834	23,787	1839	83,942	1844	95,306
1835	43,675	1840	89,684	1845	184,487

The following table represents the *general importation* of coal into the kingdom of Prussia, and into the Zollverein.

Prussian Dominions.		The entire Zollverein.‡
Years.	Tons.	Tons.
1834		60,860
1836		69,370
1838		99,620
1840	166,000	176,110
1841	192,504	197,000
1842		187,250
1843		252,560
1844	193,247	

Peat in Lower Pomerania.—Has the appearance of fossil wood, but consists of very thin parallel laminæ: fracture conchoidal and shining: structure compact, and exhibiting no traces of ligneous structure.§

Port of Stettin, in Pomerania.—Import of bituminous coal in the year 1844, received from England, Russia, and Denmark.

Value	9,224,000	francs,	=	£372,537‖
In 1842	5,450,000	"	=	220,115

Lignite with amber, at Rauchen, near Konigs-Bergen-Prusse, consists of trees of the family conifera, and genus pinite.¶

Port of Memel, in East Prussia.—English coal imported into Memel in 1842, 6921 tons; value 105,000 francs.

* London Mining Journal, Vol. II. pp. 90, 270.
† Parliamentary Records.
‡ Mouvement Commercial sur l'exposition de Berlin, 1845.
§ M. Link, Academy of Berlin.
‖ Documens sur le Commerce extérieur, Mars, 1845.
¶ Annales des Mines, tome XVIII. p. 449.

Coal Trade of Dantzick, or Dantzig.[*]

Importation from Great Britain.				Exportation by land.			
Years.	Tons.	Value. Francs.	Value. Sterling.	Tons.	Value. Francs.	Value. Sterling.	
1842	4,778			753			Duty in 1832 on for'n imported coals, 1¾ per centner, about 3s. per ton, English, = $0.72. U. S.
1843	9,493	129,806	£5,192	2,220	30,300	£1,212	

PRUSSIAN DOMINIONS.

System of Railroads in 1846.—Eleven principal routes, 1063 miles; opened for traffic, 701 miles,—cost per mile £9,400, average of 600 miles costing £5,640,000. Several other lines are projected.

Miscellaneous notes.—The first steam engine for mining purposes was established in Prussia in 1780. The first steam engine was placed in Holland in 1774: in the mine of Litry, in France, in 1749; and in those of Belgium in 1740.† The first steam engine for raising water from the Belgian coal mines was in 1725, near Charleroi, and another near Mons, about the year 1735.

The area of the Prussian monarchy is	106,302 square miles,
By return in 1837,	107,937 British square miles,
Its population being, in 1835,	13,800,000 persons,
in 1837,	14,157,573 "

MANUFACTURE OF IRON IN THE KINGDOM OF PRUSSIA.‡

In a metallurgic point of view, Prussia is divided into five districts, which are: I. Brandenbourg; II. Silesia; III. Saxe Thuringia; IV. Westphalia, and V. the Provinces of the Rhine.

I. *The District of Brandenbourg*, comprising Pomerania and the Duchy of Posen, is the richest in iron of all the Prussian provinces. The coal employed in the iron works comes from England and Silesia. In Pomerania, in 1845, were eight high furnaces, forges, and foundries.

II. *Silesia.* In Lower Silesia, only wood is employed: in Upper Silesia, both wood and coke; and in the iron works of Gleivitz was constructed, in 1795, the first furnace with coke on the European continent.

By the report of the Royal Administration of the Mines in Prussia, in 1841, there were in the Silesian provinces of Breslau, Liegnitz, and Oppeln, seventy-four foundries of iron, and seventy-nine high furnaces. Of the latter,

59	consumed	wood,
12	"	coke,
3	"	coal,
5	"	mixed fuel.

The production from these furnaces was 68,600 tons pig iron, whose value, at the works, was 15,622,206 francs, = £631,397, = $3,015,085.

* Documens sur le Commerce extérieur, Janvier et Juillet, 1844.
† Bulletin de la Commission Centrale de Statistique de Belgium, 1843.
‡ Traité de la Fabrication de la Fonte et du Fer, Paris, Dec. 1845.

III. *Lower Saxe Thuringia,* contains coal and lignite mines, but only employ wood in the metallurgic processes.

IV. *Westphalia,* possesses coal works in abundance, yet chiefly employs wood in the furnaces, and refines the iron both with coal and with charcoal, at the works adjacent to the collieries. This country draws pig iron from the Rhenish provinces, and from England.

V. *District of the Rhine.*—Vegetable combustibles are still used in the furnaces, and no furnaces have been specially erected for the employment of coke, [1840] but it is frequently used mixed with charcoal.

Table of production and fabrication of all descriptions of iron in the years 1835 and 1841, within the five metallurgic districts of Prussia, reduced to English tons.

Years.	Brandenbourg.	Silesia.	Basse Saxe.	Westphalia.	Bas Rhin.	Total. Tons.
1835	2,754	49,662	5,044	10,253	73,054	140,767
1841	12,134	77,425	7,359	28,006	97,655	222,579

Employment of Iron Wire Cables in the coal pits where steam engines are used.

M. le Bergmeister Klotz has published a note in the "*Archiv. sür Mineralogie,*" which article has been translated by M. Ch. Combes.

The translator states that twisted iron wire cables have been introduced in the shafts of extraction in the mines of the Hartz. The economy in the costs of extraction resulting from these wire cables, compared with those formerly made of hemp, soon determined the engineers and proprietors of the mines of Saxony, of Prussia, and almost all Germany, to adopt them. In France they have been slow to follow this example. The economical details, very circumstantially presented in M. Klotz's notice, appear to call for the attention of proprietors of mines, and of manufacturers of wire, in all countries; and we present the readers of this volume with some valuable practical results, obtained under the supervision of the Prussian mining engineers, which are, probably, perfectly new to them.

Hempen Cables.—Towards the close of the year 1833, the providing and maintenance of the "cables of extraction," in several of the collieries in the district of Essen and Werden, in Prussia, were given to the enterprise and competition of the manufacturers of hempen ropes; their remuneration consisting of a price agreed on for each 100 scheffel [= 147.9 English bushels] of coal extracted from the mine, or shaft.

The names of those collieries, their depth of shaft, and the prices paid for the service of those hempen cables, are as follows:

That of Saelzer, whose vertical shaft is 216 Engl. feet deep, and that of Neue Aack, which is 308 feet, Engl. deep, paying fr. 0.3608 = 3½*d.* (three pence halfpenny) = $0.07 per 100 scheffel [= 147.9 Engl. bushels] = about five tons. These terms are equivalent to $\frac{7}{10}$ of one penny Engl. or 0.01\frac{4}{10}$ American currency, per ton, as cost or service of the hempen cables.

The colliery of Wische, for a vertical shaft of 81 lachters = 152.604 metres [= 500 English feet,] paying fr. 0.4638 [= 4.494*d.* = $0.09] per each hundred scheffels. This is equivalent to $\frac{8}{10}$ths of one penny, or 0.01\frac{8}{10}$ per ton, for use of the ropes.

That of the Kuntswerk, whose shaft is 46 lachter = 152.6 metres [= 283 Engl. feet,] paying 2 silbergros 6 pfennigs = fr. 0.3092 [= 3 pence

Engl. = \$0.06 American,] per 100 scheffels. This charge is equivalent to $\frac{6}{10}$ of a penny or \$0.01$\frac{2}{10}$ per ton.

Subsequently, the price was lowered, in this case, = 2$\frac{2}{10}$*d.* English, = \$0.04$\frac{4}{10}$ per 100 scheffels. Therefore the payment for the use of the hempen ropes was reduced to $\frac{44}{100}$ of a penny, or \$0.00.88 per ton. But, it is added, at this last price, the contractor of cables suffered a loss, which he was able to prove.

The colliery of *Braut in Küpers wiese* has had for several years a contract which still subsists, by which it pays for the extraction of each 100 scheffels, by an inclined shaft, of 39 lachter [= 240 feet,] 3.596*d.* Engl. = 7$\frac{2}{10}$ cents. This sum is equal to 0.719*d.* = \$0.01$\frac{44}{100}$ per ton.

Without following M. Klotz through the details of the comparative value, weight, durability, cost, and power of the wire cables, at all the shafts, we will select the first only, the colliery of

Salzer and Neue Aack.

1. *Results with the hempen cables.*—In 1833, two cables were placed in these shafts, which lasted six months and fourteen days. They cost 917 fr. [= £37,] and raised 19,645 tons of coal. Thus the expense was $\frac{45}{100}$ of a penny = \$0.00$\frac{9}{10}$ cent per ton.

At the end of that time, in 1834, two other new hempen cables were placed in the shaft, which lasted six months and seventeen days, and the charges, amount of work, and expense per ton, were about the same as the preceding.

A third and last set of hempen ropes lasted eight months and a half; and, calculating from the data furnished by the author, the expenses amounted to 0.54 penny = 1.08 cent per ton, of coal raised.

Results with the annealed wire cables.—In 1835 the first two cables of this description were adopted at this colliery. The two, together, were 931 feet in length: weighing 898 livres [= 988 lbs.] one of them lasted one year three months and twenty-four days. The expense per each 100 scheffel amounted to fr. 0.0655 = 0.126*d.* = \$0.00$\frac{25}{100}$ per ton. The other lasted fourteen months, and the charges per ton were 0.16*d.* = 0.32 cent.

Results with un-annealed wire ropes.—In 1838, two cables of this kind were fixed, which lasted eleven months; their cost and expenses formed a charge on the coal produced, of only penny 0.089, = ct. 0.178 per ton.

On comparing these four results, their proportionate expense on the extraction of the coal is as follows:

		Penny. Ct.	
1. Contract with the hempen rope manufacturers,		0·70 = 1.40	per ton.
2. Expense when using hempen cables,	1st and 2d set,	0.45 = 0.90	per ton.
	3d set,	0.54 = 1.08	
3. Expense when using annealed wire cables,	1st cable,	0.126 = 0.25	per ton.
	2d cable,	0.160 = 0.32	
4. Expense when using un-annealed wire cables,	2 ropes,	0.089 = 0.178	per ton.

Colliery of Ver. Henriette.

Result with hempen cables.—In 1835–6, two hempen cables lasted six months and a half. The cost on the amount of coal raised in that time was fr. 0.4329 per 100 scheffel = *d.*0.84 = ct. 1.68 per ton.

Result with annealed wire cables.—In June, 1836, two wire cables were

fixed at these mines; which, after having broken five times, were laid aside at the end of four months, eleven days, of work.

The extraction of coal cost, during this time, paying first cost, fr. 0.2061 per 100 scheffel; which is equivalent to *d.*0.4, = ct. 0.8 per ton.

Two other wire cables were next introduced, and endured six months and three weeks, and were removed after having broken eleven times. The expenses attending the raising the coal, during this second period, including first cost, was remarkably low, being only fr. 0.1277 per 147 bushels, which is equal to *d.* 0.247, = ct. 0.494 per ton, on the quantity raised.

Result with un-annealed wire cables.—In May, 1837, cables of this kind, from the Hartz, were next adjusted; which lasted nearly unto the end of 1838, or eighteen months. The expenses, per ton, of coal raised were now reduced to *d.* 0.049, = ct. 0.098.

Recapitulation.	Penny.	Ct.	
2. Cost of raising coal with hemp cables,	0.84=	1.68	per ton.
3. " with annealed wire cables,	0.40= 0.247=	0.80 0.494	per ton.
4. " with un-annealed wire cables,	0.049=	0.098	per ton.

The average proportionate results of 2, 3 and 4, of these and other mines of the district, are represented by the figures or numbers, 100 : 38 : 13.

Wire Ropes in the Mining District of the Hartz.

In an address to the Royal Cornwall Polytechnic Society, by Mr. John Taylor, communicating some things that came under his notice during a recent visit to the mining district of the Hartz, the subject of wire ropes is particularly adverted to. The opinion of so experienced an authority being of no slight value, we give it in the following extracts:

"In the mines of the Hartz nothing engaged my attention more than the universal employment of wire ropes, for drawing the ores and waste from underground. This appears to be one of the most important improvements in the economy of mines that has for some time been made; and as it is but now beginning to make progress in this country, I am induced to notice it, in the hope that what experience may have been gained in Cornwall may be gathered at the next meeting of the Society: that the matter may be discussed, and the results made more generally known.

"The merit of this invention is due to M. Albert, the able and enlightened principal officer of the mining administration at Clausthal, who gave his zealous attention to this subject; and after overcoming many difficulties, succeeded in bringing them to their present perfect state. The first information respecting the use of wire ropes, afforded to the English miner, was by Count Brenner, *Oberberg Hauptman* (the title of the chief director of the mines of a country) of Hungary, by a paper which he communicated to the British Association at Newcastle, in the year 1838, at the meeting of which he was present, and did me the honour to ask me to read it for him. The subject did not appear to attract the attention it deserved; and it was not until the return of Professor Gordon from Germany, that any attempt was made to avail ourselves of the improvement.

"Of late, several persons have engaged in the manufacture, and great rivalry seems to exist as to claims to patents, and to superiority of quality. Some are in use in Cornwall, and there may now have been time enough to have gained a certain degree of knowledge of the value of this investigation.

"In the Hartz the diameter of the wires appears so small, when compared with what one has been used to look at, as to wear a very remarkable appearance. The saving of expense, when compared with the use of hempen ropes, is stated to be very great. Those I saw were made of twelve wires; but, for great depths, the upper part is somewhat stronger. The pulleys over the shaft are seven or eight feet in diameter; and some stress is laid on this, and I do not consider it a fair trial of these ropes to work them over pulleys of much smaller diameter. I was, however, surprised when I visited the iron works at Ilsenberg, at Rothehütte, and at Konigshütte, to find wire ropes used on cranes in the foundries, and in machines for raising iron ores perpendicularly in train wagons to the top of high furnaces. In these cases, the barrels on which the ropes wound, and the pulleys over which they worked, were necessarily very small in diameter. They seemed as pliant as they need be, and to have sustained no injury in use. I was informed that for such purposes the ropes were formed of a greater number of smaller wires, by which it was found that they endured the bending to a more acute angle, without injury. I notice this, to show that they may be adapted to almost every use to which cordage is applied."

The author suggests that oxidation of the wire ropes might probably be prevented by a process now much used in France, which is by coating iron with zinc, in the same way as it is covered with tin in the manufacture of tin plate. This is termed galvanising the iron, and is very successful in protecting it from rust. It is commonly applied to wire work that is exposed to the weather, such as trellis work for gardens, &c.; and is performed after the wire is woven into the forms required, and at a very cheap rate. It unites or solders the joints or crossings; gives the whole a very pleasing appearance, and is effectual in preserving it for a great length of time. This is more especially applicable for wire ropes that are extended in a rigid state; such, for instance, as standing rigging.

Wire Ropes in the English Collieries.

Since the foregoing communication was made, a great deal of discussion has taken place on the employment of these cables as a substitute for hemp in the English mines. Much information has been elicited by means of various correspondents in the Mining Journal and other works devoted to the occasional consideration of such matters.

An objection to their use seems to have pervaded the pitmen, and much opposition has been made to their adoption, without, as it appears, adequate grounds, except on account of their novelty.

This has been fully shown in a trial at law, 29th of July, 1844, at Durham. The question between the parties at issue was chiefly whether the wire rope used at the Wingate colliery, and by which the men were lowered to their work, was fit and proper for that purpose or not.

It appeared that the use of wire rope in the English collieries dated only since the end of the year 1842, when they were introduced in various parts of the northern coal-field; both in working inclines and in raising coals from the pits. Those used on the inclines were chiefly round: while those of the collieries were made *flat*, for the greater facility of rolling them on the drum.

The rope, used at the Wingate colliery, complained of, consisted of 96 wires, and was worked in conjunction with another rope of 144 wires

On account of the giving way of some of the wires of the first mentioned

rope, the workmen refused to descend to their work. It was, however, submitted to a test of ten tons weight, and a portion of it to a strain of upwards of nineteen tons; although the usual weight required was only three tons and a half. It was on the scale of one cwt. to four fathoms=four and two-thirds lbs. to each foot, and was considered capable, when new, of sustaining a weight of twenty-seven tons. Evidence was adduced that nine wire ropes had given way in the Coxhoe and Jarrow collieries; while, on the other hand, it was shown that wire ropes were used at various collieries throughout the country, and that they were generally looked upon as much safer than hemp: that they were better, and that any symptom of weakness was sooner perceived.

The cohesion in the wires in the twisted ropes is such, that the fracture of a wire originally continuous does not essentially weaken the strength of the rope, on the same principle that the fibres of which the several strands of a hempen rope are composed, do not consist of continuous threads throughout, but are made up of a multitude of pieces, which vary from a few inches to a few feet in length each.

The decision of the jury, in this case, and the valuable evidence produced, appear to demonstrate the superiority of the wire rope over that manufactured of hemp.*

Wire ropes, both flat and round, are now in use in the English collieries, of the kinds patented by Smith and by Newall & Co. At the beginning of 1844, at the Gosforth colliery, Newcastle, two flat wire ropes, made by Newall & Co., were in daily use: their weight, in proportion to hemp, being as 21 cwt. to 47 cwt., and the power of drawing increased by about 30 tons a day. One at Ince colliery, Wigan, had been in use eight months without deterioration. Those at Rainton colliery, after seventeen months work, remained in excellent condition.

Several other collieries had been using flat wire ropes for more than a year, without depreciation of their capability. Others are mentioned which have been in constant use during fourteen, sixteen, and eighteen months, uninjured. Their cheapness and durability are asserted, by practical managers of mines, to exceed greatly those of hemp. On the Durham and Sunderland railway were thirty-seven miles of wire ropes; some of which, according to the engineer, had been at work two years,—three times the duration of hemp ropes,—and are still in use and apparently very good.

Wire ropes first came into notice about the year 1836, since which time both round and flat cables are in common use in the English collieries, both for shafts and inclined planes: for the latter of which they are especially adapted.†

We perceive, however, that this subject is still open to discussion, and by no means settled. It has been charged against the iron pit ropes that frequent accidents and loss of life have occurred from their breaking; and it is even said that the flat hempen ropes are coming into use again. The colliers observe that "the hempen ropes give notice before they break, but the iron ones do not."‡

Iron Wire Cables in France.

The utility of this invention has been carefully investigated in France. Among other articles on this head, during the year 1845, in the Annales des

* Mining Journal of London, August 3d, 1844.
† Dunn's History of the Coal Trade, 1844, p. 61. ‡ Mining Journal of London, Jan. 3d, 1846.

Mines, is a useful one on the fabrication and employment of these cables by M. Cacarrié, mining engineer,* and another memoir on the same subject by M. Pernollet.†

Wire Ropes and Cables in America.

These have been introduced, in some cases, successfully, in the United States. In July, 1839, a wire rope, three-fourths of an inch, was applied to one of the hoisting machines of the Philadelphia tobacco warehouses.

The American Railroad Journal contains an account, dated September, 1843, by J. A. Rœbling, C. E., of his introducing wire ropes on the *Inclined Planes* in Pennsylvania.

Three wire ropes, measuring in the aggregate 3400 feet, 4½ inches in circumference, were put in operation on the inclined plane No. III., of the Alleghany portage railroad, in 1842; and were used a considerable portion of that season and the whole of the year 1843. The hempen ropes, heretofore used, were 8½ inches circumference, made of the best Russian or Italian hemp; and could not be trusted, in safety, longer than one season. Another wire rope, 5100 feet long, in four pieces, was about to be laid down on Plane No. X.

The first wire rope placed on this line, or in connection with it, was 600 feet long, 3½ inches in circumference, and had been already in operation two years or seasons, at Johnstown, January 1, 1844.

Two more iron wire ropes were put in work in 1842, one at Hollidaysburg, the other at Columbia, in Pennsylvania. The engineer asserts that wire cables deserve all the preference usually assigned to them over hempen ones, where the former are placed in exposed situations, and where great strength and durability are required. In the ropes in question the individual wires, as well as the strands and ropes, were separately coated with varnish during the manufacture.

The saving by wire, instead of hempen ropes, in 1844, is reported‡ to be $1,465 per annum for each plane, or $14,650 annually for the ten planes of the Alleghany portage railway.§

Wire Tiller Ropes in the United States.—By an article quoted from the "Cincinnati Republican" in 1840, it appeared that, at the beginning of that year, 264 steamboats on the western rivers had adopted the use of wire tiller ropes; although it was only eighteen months since their first introduction. The wire tiller rope of the steamer "Commerce," which rope had been heated red hot for at least an hour, came out of the fiery ordeal without the least injury.‖

Wire ropes for the shafts and inclined planes in the collieries around Pottsville, are in use; but opinion is divided on their utility.

* Annales des Mines, 1844, Liv. III. p. 495 to 504. † Ibid, Liv. IV. p. 133.

‡ American Railroad Journal, December, 1843. Journal of the Franklin Institute of Philadelphia, January 1, 1844. Mining Journal of London, April 27, 1844.

§ Hunt's Merchant's Magazine, Art. II. August, 1845, p. 132.

‖ Hazard's United States Register, April, 1840.

KINGDOM OF BAVARIA.

Rhenish Bavaria, Palatinate of the Rhine.—The coal of this Rhenish province, of course, is not at present available in Bavaria proper; the distance being too great.*

Rhenish Bavaria exports coal to France. Many coal mines are worked in this country, which includes the extensive coal basin of the *valley of the Glane.*

This coal is bituminous, and of good quality, according to Mr. Burr. Near Bingart it is procured at the depth of 112 feet. The seam does not exceed two feet in thickness; but it appears that in this vicinity, which forms the northern termination of the coal-field, the beds thin out, as they rise to the surface. At Saarbrucke, a seam of coal is worked which is from ten to twelve feet in thickness; but this belongs to the rich *coal-field of the Sarre,* which forms a separate basin from that of the Glane, and lies some distance to the south of it.†

Estimated quantity of coal produced in 1844, 50,000 tons;‡ but subsequent returns show an amount of 60,000 tons, from about forty principal coal mines.

This monarchy contains 28,435 square miles; population 4,300,000 persons.

BAVARIA PROPER.

Territory of the Danube and Maine.—A considerable number of coal mines are in operation; but there exists such an immense quantity of wood in the Bavarian forests, that the quantities of coal produced are comparatively inconsiderable; not being a tenth part of what they might easily amount to, if required.§

Messrs. Sedgewick and Murchison, in describing their sections of the tertiary formations of Bavaria, remark no less than three or four distinct zones of coal or lignite, separated from each other by sedimentary deposits of enormous thickness.||

A grand canal is now in progress through Bavaria, to connect the Danube with the Rhine, and consequently to unite the Black Sea with the German Ocean; a work of immense importance to this country and to the commerce of Europe. The first railroad, with steam carriages, introduced upon the Continent, was opened in 1835, between Nuremburg and Furth, and similar projects have been subsequently carried into effect in many parts of the kingdom.

Peat.—Employment of Peat in the Iron works of Weiherhammer.

This peat is procured from the numerous tourbieres of the Fichtelgebirge, which are worked during the fine season, and the turf is left to dry for six months: then it is stored, but is not employed in the iron works until a year

* Correspondent of the Times, March, 1842.
† Mining Review, No. IX.
‡ Mouvement Commercial, 1845, No. 241.
§ McCulloch, Bavaria.
|| Proceedings Geological Society of London, Vol. I. p. 158.

after it has been dug. The peat is of good quality, compact, heavy, yet containing no more than from 3½ to 5 per cent. of ashes.

At the Weiherhammer works are two puddling furnaces, one of which is generally in activity. The puddled iron is converted into bars in the ordinary charcoal forges, or in a chaffery [réchauffer] fire, which is fed with peat alone. As the peat which is dried in the air produces with difficulty a temperature high enough to remelt the iron, the combustion is hastened by means of a forced current of air. This air, furnished by the blowing machine of the refining furnace, and previously heated, is impelled by five conical tuyeres; and the heat produced by the combustion of the peat being directed into the interior of the furnace, the remelting of the pig metal is effected with the greatest facility. The result of these operations is as follows:

To produce 100 kilogrammes of bar iron,=220 lbs. English:—fuel required, all peat, 2.416 stère,=85.32 cubic feet, English; pig metal employed, 128 kilogrammes,=281 English lbs.

These proportions are equivalent to 1 ton, and 621 lbs. of pig metal, and 868 cubic feet of peat, to make 1 ton [2240 lbs.] of bar iron.*

Lignite of Bayreuth, Upper Mayne, transferred to Bavaria.—A fossil fuel of sensen, offers, under the microscope, a singular mixture of various parts of plants, and even of vessels spirally disposed.†

Petroleum Springs at Tegernsee.

Railroads.—The Bavarian system of railroads, in 1846, comprehended three great trunk lines, whose total length was 573 English miles; of which 159 miles were then opened for commerce.

KINGDOM OF WURTEMBERG.

Coal is found in this country, although it is not much worked.

Lignite also prevails in some parts.

Timber being so abundant, has probably rendered it unnecessary heretofore to make researches for coal. The forests are an important source of wealth. The timber annually cut in the Black Forest is estimated to produce upwards of 400,000 florins, = £34,166.

Peat.—Employment in Reverberatory and other Furnaces in Wurtemberg.

At Köenigsbronn, they execute with peat alone, the refining, and the second fusion of the pig metal; its puddling, the reheating of the lumps, and rolling the bars and plates; in fine, all the operations which are made with coal in the English forges. The works are under the care of M. Veberling.

* Sur l'emploi de la tourbe dans la métallurgie du fer, par M. A. Delesse; Annales des Mines, 1842.

† Experiments on the Structure of Coal, by M. Link.

The peat is of three kinds, as follows:

1st. *Peat of Dottenhausen.*—Fibrous, or consisting of interlaced filaments, its colour varying from dark yellow to brown.

Peat in iron making.—Comparative weight and volume of a brick of each kind.

After drying in the air.			After desiccation in the kiln.		
	Value in cubic centimetres.	Weight in grammes.	Volume in cubic centimetres.	Weight in grammes.	
Yellow kind,	1304	258	994	231	Ashes 3½ to 4 per cent.
Brown kind,	799	218	611	196	

2d. *Peat of Günzburg.*—Compact; having an earthy aspect; colour deep brown, often passing to black; ashes, six or seven per cent.

3d. *Peat of Wilhelmsfield*—Dark brown; resembling straw, to a certain extent. Weight of ashes, 5½ to 6 per cent.

	Volume in cubic centimetres.	Weight in grammes.
Before desiccation in the kiln,	813	265
After,	703	231

This species is first dried in the air, at the place where it is dug. The bricks are placed upon a floor, and are turned from time to time. At the end of eight or ten days they are collected in little piles, between which the air circulates freely; and three weeks after, if the weather has not been too rainy, they can be transported to the iron works, to be further dried in kilns: the description and details of which we cannot follow here, and which bricks are either heated by means of the waste heat of the furnaces, or by ovens constructed for the express purpose; or by the union of both. These turves, after being thus artificially dried, absorb anew the moisture of the atmosphere. It is therefore necessary to store them in places which are as dry as possible. However, the quantity which they will thus absorb is so small that they remain several months, and even a year in the storehouses, without losing their applicability to metallurgic uses.

Of the three species of peat that we have enumerated above, the proportionate diminution of their weight and volume when dried, is as follows:

	1st.	2d.	3d.
Diminution of volume,	0.24	0.10	0.135
Diminution of weight,	0.10	0.19	0.12

Cost of 1 kilog. or metrical quintal [= 220 lbs.] delivered at the iron works of Itzelberg, fr. 1.29 c., = 1*s*. 6*d*., = $0.36; being about $3.50, or from 13*s*. to 15*s*., per ton; the distance from Königsbronn being 2 kilometres, [= 1⅓ mile.]

M. Berthier's analysis of the peat of Königsbronn is as follows:

Carbon,	24.40
Volatile matters,	70.60
Ashes,	5.00

It is employed without admixture of other fuel, in the refining, puddling, and reverberatory furnaces.*

* Sur l'emploi de la tourbe dans la metallurgie de Fer, par M. A. Delesse, Annales des Mines, tome II. 1842, p. 758.

KINGDOM OF SAXONY.

Comprehending the circles of Dresden, Leipsig, Zwickau and Bautzen. About half a million of scheffels of coal,=250,000 tons, were annually produced in 1835, but the mines are made to yield at present a much larger amount.

At Schonfeld, near Zwickau, are extensive mines of bituminous coal. Here the coal alternates with porphyry, and there are nine or ten known beds. These coal-fields lie on both sides the Mulda river, to the south of Zwickau. At Gibienstein and at Seefeld, coal measures occur; also between Chemnitz and Frankenberg.* They are also found in many places skirting the northern base of the Erzgebirge, [ore mountains.]

At Planenschen Grund, near Dresden, is an extensive coal-field, discovered a few years ago. There are four coal seams, overlying secondary porphyry, which reposes upon sienite. This coal is bituminous. Of late, the mines have been profitable, and promise a good supply and return for the future.

This monarchy contains 28,830 square miles. Population, 4,500,000 persons.

Production of anthracite—in 1835, 250,000 tons; in 1839, 292,000 do.; in 1844, 400,000 do.

Some additional notes have been furnished us, relative to the coal mines of *Dresden and Zwickau.*

Dresden Coal Basin.—The largest coal-field of Saxony, situated on both sides of the little stream called the Weiseritz, about six miles from Dresden, is from west to east, about five miles, and about one and a half to two miles in breadth. The coal formation rests immediately on porphyry and sienite, and is covered with new red conglomerate, sometimes as thick as one hundred fathoms. There are three coal beds in this formation, separated by carboniferous sandstone, and covered with clay-slate. Only one of these beds is, as yet, worked, which averages twenty feet in thickness. The group of coal seams have a general dip to the south, of from 10° to 20°—sometimes as much as 40°.

This coal is bituminous, and the coke therefrom is the chief fuel at the silver furnaces of Freiburg. In 1839, the product of the mines was 900,000 Prussian tons,=180,000 English tons.

It is also used at the gas works in Dresden. Forty-seven cubic feet of coal yields four and eighty feet of gas.

Coal Mines near Zwickau.—The coal-fields of Saxony near Zwickau are of a younger formation than those near Dresden. This region is not so large as the latter. It extends about six miles in length, from north-east to south-west, and has a declination, towards the north, of 10° to 15°. The underlying rocks of this field are greywacke and greenstone. The overlying formation is a grey conglomerate, of varied thickness, and new red conglomerate. The Zwickau region has nine coal beds, the lowest of which are the thickest. The lowest coal seam of the series is from five fathoms to twelve fathoms in thickness.

The Zwickau coal is denominated Pech Kohle, [pitch coal,] and is con-

* De la Beche, Geological Manual, p. 420.

sidered better than that of the Dresden coal-fields, and in quality even equal to some of the best English coals. One hundred weight of this coal is considered an equivalent for two hundred weight of pine wood.

Consumption in 1839, 500,000 Prussian tons,=100,000 tons English.

Silicified Fern Stems.—In the new red sandstone, in the neighbourhood of Chemnitz, in Saxony, silicified stems of ferns occur. They are of great beauty, and the organization of the original is so well preserved by the silex, that slices, examined by the microscope, display the peculiar structure of this family, as perfectly as in the recent plants. Transverse sections exhibit the arched bundles of vascular fibres, which compose the ligneous cylinder, surrounded by the cellular tissue, as in the living stems.*

Wood.—About one-third part of the forests belong to the crown; yielding an annual revenue of $2,000,000. Nearly ten thousand individuals are engaged in wood cutting.†

Besides the coal beds already designated, there are several others of importance, the chief of which is near Haynichen, and belongs to the older formation of the three. It reposes upon gneiss, and is covered by the old conglomerate.

The yearly consumption, in 1839, was 12,000 Prussian tons.

Iron Manufacture in the Kingdom of Saxony.

In 1843,‡ production of cast or pig iron, 2,500 tons, of the value of £32,000; wrought iron, 2,776 tons, £57,000.

In 1845, sixteen high furnaces, twenty great forges, fifteen cupola furnaces, fifty refineries, eight others. Annual production, 15,000 tons; castings, 15,000 tons; forged, 4,000 tons; employing 4,500 workmen, on whom depend 15,000 persons. Thirty factories for the construction of machines, employing 1,500 workmen, and supporting 4,000 persons.§

GRAND DUCHY OF BADEN.

Bas Rhin, of the Germanic or Prussian, or Custom House League. Coals are mined in the vicinity of Offenburg, in the valley of the Kinsig.

Anthracite.—At Berghaupten and Zunsweiler, anthracites occur, and are worked, in supposed transition strata. This carbonaceous system, Mr. Elie de Beaumont states, forms a true basin-shaped deposit, which offers no analogy to the other coal measures worked near there.||

A limited quantity of this anthracite is transported into France by way of

* Mantell, Medals of Creation, Vol. I. p. 128.
† McCulloch, Gazetteer, Saxony, Zwickau.
‡ "On the Statistics of the Mines of Saxony." C. Fox, Mining Journal, May 23, 1846.
§ Association Allemande, Faits Commerciaux, No. 241, 1845.
|| De la Beche's Geology of Devonshire and Cornwall.

Strasbourg, and is confounded in the custom houses, with the coal imported from the basin of Saint Ymbert, (Rhenish Bavaria,) under the general name of German coal.*

Exportation of anthracite from Berghaupten into France, by Strasbourg, in 1837, 190 tons; in 1838, 400 tons.

Œningen—belonging to the Grand Duchy of Baden—between Constance and Shafhausen.—A celebrated lacustrine lignite deposit was here described by Mr. Murchison, in 1830. This formation is remarkable for the remains of vertebrated animals found therein, for the most part of the class "Rodentia," and had previously received the attention of Cuvier and other learned naturalists. A synopsis of the mammalia, birds, fishes, reptiles, insects, and plants, accompanies Mr. Murchison's memoir. Most of these are almost identical with species existing at the present day.†

HESSIAN STATES,

HESSE CASSEL, HESSE DARMSTADT AND HESSE HORNBERG.

GRAND DUCHY OF HESSE DARMSTADT.

Coal, of inferior quality, [lignite] is abundant in the Upper Hesse Provinces, and in scattered beds through the other provinces; but the total yearly produce, until lately, was not more than 280,000 quintals, or 14,000 tons. True coal has not been discovered, that we know of.

The production of coal [lignite] in the Hessian States, in 1844, was estimated at 50,000 tons.‡

Peat abounds.

GRAND DUCHY OF MECKLENBERG SCHWERIN.

By treasury order, November 1, 1843, the Mecklenberg Flag is placed on the same footing as that of the Hanse Towns, with respect to the reduced duty on the exportation of coal from Great Britain.§

Mecklenberg is a country essentially agricultural.

GRAND DUCHY AND PROVINCE OF LUXEMBURG,

Partly appertaining to the kingdom of the Netherlands, [Holland,] since 1831, and part to Belgium.

On account of the absence of coal, in this district, wood has been heretofore used for the smelting of iron ore; there being few countries in which

* Resume de travaux statistiques, en 1838. Paris, 1839.
† Proceedings of the Geological Society of London, Vol. I. p. 167.
‡ Mouvement commercial, 1845, No. 241.
§ Pope's Journal of Trade, p. 241.

that mineral is more abundant. It is estimated that the entire Duchy contains 211,000 *bonniers*, or about 520,000 acres of forest. These works are an important source of wealth; the annual produce of timber and firewood being estimated at nearly 1,100,000 steres; which are equal to 400,000 French cordes, of 35½ cubic feet, English, each.

Since 1837, however, coal has been admitted into Belgian Luxembourg, where iron making is principally conducted, from Rhenish Prussia, at the reduced duty of 1 franc per 1000 kilogrammes: = 10 pence, English, or $0.20, American, per ton: and, in consequence, the production of iron is probably on the increase.*

Peat or *turf* is plentiful in the province, in beds of from four to twelve feet thick; and furnishes a cheap fuel to the poorer classes. Its ashes, mixed with sand, are much used, as a very successful manure.

ELECTORATE OF HESSE.

At Meissner, columnar anthracite forms the upper part of a bed of brown coal, which is covered by basalt, of great thickness. The influence here of the basalt, in converting wood coal to anthracite, is exhibited in a very interesting manner. It appears that this conversion has only extended to the upper part of the seam, leaving the lower portion, still an earthy, fibrous wood coal.†

The lignite of Meissner has a peaty texture, according to the experiments of M. Link.‡

Hesse Cassel, Electoral State.

Production.	Quintals.	1835. Engl. Tons.	1845. Tons.
Bituminous Coal,	300,000	15,000	
Bony or Brown Coal,	400,000	20,000	
Total,		35,000	50,000

The above table shows the annual production.

Besides turf, in large quantities, coal of a good quality is abundant throughout the country, but the inhabitants have a prejudice against it, and it has not been brought into general use.§ The Brown coal of Cassel is considered to be of more recent origin than the chalk, and of the age of the plastic clay.||

M. E. Kuhnert has furnished a series of analyses of the combustibles of the country of Cassel. Some of the localities are as follows.

Meissner.—Radiated anthracite, brilliant; ashes gray. Pechkohle¶—conchoidal fracture, brilliant, yields much gas, and flame—ashes white.

Hirschberg.—Pechkohle, same as the last.

Habichtwald. do. do.

Hirschberg.—Dry, sparkling coal.

* Annales des Mines, tom. XVIII. p. 449.
† Bakewell's Geology, Third Ed. p. 170, note.
‡ Annales des Mines, tome XVII. p. 575.
§ M'Culloch's Geographical Dictionary, 1097.
|| Journal of Science and the Arts.
¶ Peck, German. Pitch, English. Tar—Poix, French.

Lignite of Habichtwald, passing into the Pechkohle. It forms the principal part of the mine; fracture, a little conchoidal; rather bright; colour pitch black; ashes yellow-orange.

Lignite of Hirschberg. These are true lignites: colour deep brown; fracture earthy. They have many impressions of vegetables.

Lignite having the texture of wood.—Rigenkuhl. Colour brown; texture that of wood. It burns with a strong flame: rather brilliant in the transverse fracture.

Lignite of Stillberg near Sohrwald, resembling that of Hirschberg.*

See tables at the end.

DUCHY OF NASSAU.

Brown coal, in abundance.

We have been favoured with some notes, of a business character, respecting some of the lignite mines of Nassau; recently made by an English mining engineer of much observation.

Hackenburg, 27 miles above Coblentz. The lignite here rests upon basalt, and its beds are of immense thickness. Brown coal can be obtained cheaper than any coal can be mined and sold in England.

Its cost at the mine, 1200 lbs. 1*fl.* 20*kr.* [= 2*s.* 2½*d.* Engl.] which is 4*s.* 1½*d.* Engl. = $1.00, U. S. currency, per ton, Engl.

It is customary to coke the brown coal, and for economy to employ a mixture of this coke and charcoal in the iron furnaces.

When coked and freed from its impurities, the brown coal presents a very splendid appearance.

The brown coal used in iron works, is stated by a practical person, to be effective in comparison with stone coal, in the proportion of 1½ to 1; or, at the worst, of 2 to 1.

Mine of Concordia, 4½ miles from Hackenburg. By a longitudinal section which has been shown to us, the lignite beds appear to be undulating, and rest upon basalt. These seams are proved. The lowest is 6 feet thick, and in some mines 10 to 14 feet thick, and even much more occasionally. The middle vein is 5 feet, and the upper seam (not worked) two feet.

The coal at the Concordia mine can be raised to the surface for 40 to 45 *kreutzers*, per *lain* of 1000 lbs. = 2*s.* 4*d.* to 2*s.* 9*d.* = $0.57 to $0.66, per ton. Price per *lain* (of 1000 lbs.) at the mine, 1*fl.* 45*kr.* = 3*fl.* 52*kr.* = 6*s.* 6*d.* [= $1.56, per ton.]

Comparative value of Fuels.

Lignite to coals, about double quantity, to obtain equal results.

Cost of lignite for a day's consumption at an iron work, here, of Brown coal, coked, £2 12*s.* 6*d.*; of Rohr or Stone coal £3 15*s.*; of Saarbruck coal, Prussian, £3 15*s.*

Mine of Neue Hoffning (*New Hope*). Very good Brown coal, 15 or 16 feet thick.

Price of lignite, per *lain* of 1000 lbs. = 46 kreutzers, for mining and delivering at Grass, which is equivalent to 1*fl.* 43*kr.* = 2*s.* 9*d.* [= 66 cents, per ton.]

* Annales des Mines, 1841, Vol. XIX. p. 608.

Selling price at the mine, per *lain*, 1*fl.* 30*kr.* = 3*fl.* 21*kr.* = 6*s.* 1*d.* [= 1.46, per ton, Engl.] Royalty or Rent, $\frac{1}{84}$ of profit.

Price of charcoal, 2*s.* = $0.48, per 110 lbs.

Breisschied Mine. Two seams of Brown coal are found, and the boring was continued, to ascertain the number and thickness of the lower layers.

Herr Zinkraff's experiments on an improved method of coking lignite are perfectly satisfactory. They show that these are superior to the Russian lignites, and that the coke thus made, can be advantageously used in steam engines; in the reduction of copper and lead ores; and in the smelting of iron.

The cost of this lignite at the mines is 1 florin, per 1000 lbs. [= 3*s.* 9*d.* = $0.90, per ton.]

The loss of weight, by evaporation of moisture, of lignite after being brought to the surface, is from 1300 lbs. to 1400 lbs. out of 10,000 lbs.; when sold in the dry state.

The arrangements for concessions of areas of land, for the purpose of working minerals or coal, are chiefly these:—

1. Schurfschien, or leave to search, generally over an extent of three miles.
2. Muthing, or temporary grant for a few months, preparatory to a Belchnung.
3. Belchnung, or perpetual conditional grant.

DUCHY OF COBURG, OR SAXE-COBURG GOTHA.

The most southern of the independent Saxon principalities. Coal is mined, and also lignite, at Coburg and to the east of Spittelstein. These lignites belong to the age of the quader-sandstein.

GRAND DUCHY OF SAXE-WEIMAR, OR WEIMAR-EISENACH.

The *Thüringerwald*, or Thüringian Forest. Coal is raised in this state, but in no great quantity.

Thüringia, Thüringerwald, is remarkable for the presence of a bituminous cupriferous schist, which contains a great quantity of fossil fishes, crushed; and are even converted into a species of coal, occasionally used for fuel;—thereby demonstrating the carbonaceous transmutation of even animal matter.

Lignite occurs.

A bed of earthy brown coal, at Artern in Thüringia, is the only known locality for the mineral resin called *Mellite*—the Honigstein of the Germans. M. Göppert ascertained that the wood of this lignite belonged to the family of Conifera, and to the genus Pinus.*

The production of coal and anthracite in Lower Thuringia, in 1835.

Coal,	17,681
Anthracite,	293,910
English tons,	311,591

* McCulloch,—Geographical Gazetteer, Vol. II.

At the present time the annual yield of the mines near the Forest of Thüringen is much larger.

Amber, sometimes, in the lignite of this region.

DUCHY OF BRUNSWICK.

This small duchy, although celebrated for the rich metallic stores it contains, particularly in the Hartz mountains, is not prolific in coal, although that mineral is by no means absent. In the Brunnenholz, near Helmstadt, is a coal mine, with two shafts, and another near Walkenreid.

The Elm, a slight range of heights between the Acker and the Aller, contains seams of iron and beds of coal. Asphaltum and other bituminous substances are found in many parts of the Hartz mountains, especially at the Rammelsberg, and Iberg.

Railroads.—Small as is the area of this duchy, she has already (1846) completed seventy-five miles of railroad.

SPAIN.

Area of the Spanish monarchy, and the Balearic islands, 182,758 English square miles. Population in 1837, 12,168,774 persons.

SPANISH SYSTEM OF CURRENCY, WEIGHTS, AND MEASURES.

Currency.

The gold doubloon, or quadruple pistole of 1801, = $15.63¼ U. States.
The gold pistole of 1801, 16*s.* 9*d.* English, = $3.88.4 U. States.
1 Piastre = 20 rials = 5 f. 43 ct. = *s.*4.384 = 4*s.* 4¼*d.* Engl. = $1.05 U. S.
1 Rial, or Réal de Veillon = 0 fr. 27 c. = *d.* 2.616 = 2½ *d.* Eng. = $0.05 U. S. = 34 maravédes, = 8½ cuartos.
19 Rials are considered = 5 francs of France.
90 Rials, = £1 English.
Par value of £1 English in London, = 6 dolls. 2⅝ rials.
1 Libra Catalan, = 2*s.* 4*d.* English, nearly.
1 Réal of Barcelona, = 4*d.* English.

Weights.

1 Quintal of Asturias, by which coal and iron are sold, = 69 kilogrammes, = 155 lbs. avoir., = 14.5 quintals to 1 ton English.
1 Quintal of Catalonia, = 91 lbs.
1 Quintal of Castille, = 46 kilog. 10 grammes, = 101 lbs. Eng. = 100 lbs. Spanish. It is divided into 4 arobes of 11.50 kilog. each, = 25.3 lbs. Eng.
1 Quintal macho, = 77½ kilogr. = 170½ lbs. Eng. = 13 to 1 ton.
Another quintal of 50 kilogrammes.
4 Arobes, = 1 quintal, = 102 lbs. English.
1 Livre or Spanish pound = 0.46 kilogrammes. The livre is divided into two marcs.
100 lbs. of Barcelona, = 82.215 lbs. avoirdupois.

Measures of Length.

1 Vara or ell, [Vare Castellane,] = 0.8359 metre, = 2.742 ft. = 33.38 inches.
1 Burgos standard foot, in general use, 0.2786 metre, = 0.914 ft.
1 Madrid foot, very little used, = 0.2826 metre, = 0.927 ft.
1 Spanish foot, = 2.826 Fr. decimetres, = 11.12 English inches.
107.913 Spanish feet, = 100 English feet.
100 Spanish varas, = 92⅔ English yards.
1 Spanish league = 7,416 English yards, = 6.781 Fr. kilometres, nearly 4¼ English miles.
100 English miles = 27.732 Spanish leagues.

Measures of Area.

1 Square league, = 17.75 English square miles.
1 Spanish fanegada, = 5,500 English square yards.
10 English acres, = 8.800 Spanish fanegadas.

Measures of Capacity.

1 Farrega of corn, = 3439 cubic inches, = 1.599 bushels, = 56.351 Fr. litres.
1 Farrega of corn, = 7.79 Imperial bushels.
1 Farrega of salt, = 25 lbs. Spanish.

Import duty on coal in foreign vessels, 3 reals de Veillon, = 0 fr. 75 cts. per quintal, = 12*s*. 8*d*. English; = \$3.06 U. S. per ton.
Import duty on coal in Spanish bottoms, 9*s*. 8*d*. English, = \$2.34 U. S.
Export duty, in 1844, 2*s*. English, = \$0.48 U. S.

Recent progress and advance in Coal Mining.

It was not long since remarked, in an anniversary address to the Geological Society of London, that "the mineral structure of Spain, notwithstanding its proximity to France and England, and the long-continued military operations of both these nations upon its territory, is less known than that of any other portion of civilized Europe. The unhappy circumstances of the country have long abstracted the attention of the Spaniard from researches of science; and the difficulties of travelling in the midst of civil commotions, have deterred even the enterprising spirit of neighboring geologists from endeavouring to fill up the lamentable blank which Spain still presents upon the scientific map of Europe."*

An article of the "*Gazette d'Augsbourg*," of the 9th June, 1844, thus expresses itself on the richness of Spain in iron and in coals.

"The mineral riches of Spain are considerable. The mines of iron and coal, particularly, nearly neglected, even at the present moment, begin to attract attention. They are distributed in several provinces, but prevail principally in the north. The iron and steel works are ancient in the Basque provinces, but the extraction of coal is quite recent. The richest coal beds are those of Santander and Asturias. Under the regency of Espartero, several Spanish companies were formed for the working of them: recently, a French company has been in operation. It has been ascertained that the coal-field of Asturias yields to no other for various industrial purposes. As in England, the coal and iron ore are in the vicinity of each other.

It was estimated that the consumption of coal in Spain only, for 1842, was 62,000 tons: but more than half was imported from England. The duty laid upon foreign coal is of no service to the indigenous works, and does not restrain the industry employed on them. That tax might without inconvenience be suppressed. These works are very promising. The internal consumption increases rapidly; in 1843, it had doubled. The porcelain manufactory at Seville alone absorbed more than 10,000 tons of coal; while steam navigation on the Guadalquivir and upon the entire coast, requires much more. It is true that, for a time, the Spanish coal will compete with that of England, for the supply of the south and west of France."

* Proceedings Geological Society, London, Vol. III. p. 259.

A proposition was made, in 1844, to the Spanish government, by an English company, to construct a railroad fram the Puerto de Aviles, in Asturias, to Madrid. The capital is said to be two millions of francs, and a lease for eighty years is demanded.* We have more recent information on this point, under the head of "Asturias."

Spain is rapidly acquiring importance as a mining country.

In 1844 it was ascertained that the number of persons employed in mining was	29,937
The number of horses, mules and oxen engaged there,	3,109

CENTRAL ASTURIAS.

Province of Asturias in Old Castille.—M. Haussman, in 1831, contributed some information on the geology of Spain, and referred particularly to the extensive beds of coal in the Asturias, which prevail as far as the borders of Galicia, westward; the frontier of Leon, southward; and are prolonged eastward into the province of Santander, and even reach the sea.

In the Bulletin of the Geological Society of France, Vol. X. p. 100, is a brief account of this coal-field of Asturias, by M. Buvigniér, 1839. From this we learn that the province is almost entirely composed of the coal measures: consisting both of anthraxiferous and slaty coal, in beds variously inclined and contorted; often nearly vertical, and even reversed, [renversées.]

The coal seams are here often very numerous: their thickness varying from 33½ inches to 6½ feet. Some of them are even 13½ feet thick.

The vertical position of these coal beds, and their facilities of approach, present great advantages for *exploitation* or working. The mountains attain an elevation of from 2276 feet to 2616 feet above the level of the sea.

From these observatsons, the author calculated that the two concessions of *Sierro* and *Langueo*, more especially the object of his investigation, would suffice, during more than one hundred and thirty years, for a daily production of three hundred tons, before it became necessary to attack the parts which are below the levels of the valleys, which are from 984 to 1640 feet above the level of the sea.†

At Sama, in the Asturias, the coal mines are beginning to be worked, on a large scale. A railroad from them to the small port of Gijon, affords the produce a ready entrance into the Bay of Biscay. This railroad, although it runs through such a mountainous country, has not a greater inclination of its plane than five in a hundred.

Several shafts have been opened, and galleries traverse eleven beds of coal, said to be equal in its quality to the best Newcastle coal, and in great abundance.

These mines will form the groundwork of a brisk trade with Bayonne, Bourdeaux, and the whole of the basin of the Garonne, where hitherto all the coal used has been drawn from England or Belgium.‡

In the Pyrenees, and near Oviedo, the capital of the Asturias, anthracite occurs.§ The anthraxiferous formation extends south-eastward, to the frontiers of Leon; and, to the north-east, it is prolonged into the province of Santander, and northward to the coast of the Bay of Biscay, at Riba-de-Sella.

The province of Asturias is every year increasing in estimation, by reason

* Observateur des Pyrenees, Nov. 30, 1844.
† Bulletin de la Société Géologique de France, Tom. X. 1839.
‡ Mining Journal, Dec. 20, 1840. § Ibid., 1842.

of its mineral resources. Lead, copper, iron, zinc, and lastly coal, are all concentrated within a short distance of each other; and iron works are projected for the sake of employing the contiguous coal. This coal continues to be favorably spoken of, after some years of trial. An immense market is now open to all the northern and western ports of Spain, as well as those of southern France.

"The Asturian Mining Company" in operation here, obtain prices for their coal which yield a large profit.* The "Espada Colliery Company" are established at Oviedo.

M. Berthier furnishes the analysis of the coal from seven different mines in this province. This region appears to possess a great number of beds, but unfortunately the combustible is not always of the first quality. The examinations furnish the following results.

1. *Mine of Clauzel.* Although in compact and hard masses, it presents here and there some traces of ligneous structure, and as the volatile matters amount to fifty-three per cent., it is evident that this combustible is only a lignite.

2. *Mine del Regueron,* also approaching nearer to the lignites than to the true coals, as regards composition. Volatile matter, forty-four per cent.

3. *Veta del Medio,* 4. *Mine of Venuca,* 5. *Pic des Agilard,* 6. *Veta des Allemands,* 7. *Veta del los Creston,*	The coals from these mines have a foliated or schistose fracture in one sense, and unequal in the other sense. They are proper for furnaces and for boilers, but not so much so for the forge or for high furnaces. Makes a coke. Volatile matter, forty per cent.

Asturias furnishes coal to various ports on the coast of Spain, and particularly for the steamboats at Cadiz, and for the iron works of Marbella, and Malaga, and the lead works of Adra.

In an address to the Central Mining Junta of Carthagena, by the Directors of the Espada Colliery Company of Oviedo, in 1843, it is stated that the Asturian coal-field contains one hundred and ninety-two superficial leagues, [= 3408 square miles, English,] including that portion which extends into the province of Santander; and that new discoveries are constantly taking place.

	Years.	Sp. quintals, 22 to 1 ton.		Engl. tons.
The amount of coal shipped, chiefly from Gijon, was, in	1840	90,000	=	4,090
	1841	149,466	=	6,800
	1842	495,295	=	22,335
	1844	676,717	=	30,759

It is to be borne in mind that during the above periods, neither the Anglo-French nor the Espada companies shipped a single quintal.

The coal proprietors of Asturias call upon the government for a protective tariff. They ask for heavy duties upon foreign coals, in which they would merely follow the example of other nations, by availing themselves of a principle of economy universally acknowledged to be just; that is, favouring the national industry by protective duties, so as to enable it to compete with that of foreigners.

To this it is urged that the adoption of an exclusive principle is not the best mode of governing, because it is not applicable to all cases and circum-

* Mining Journal, 9th March, 1844.

stances. It is remarked that the quantity of coal mined in Asturias is by no means adequate to the supply of the twenty-seven smelting establishments on the Mediterranean coast, now dependent on foreign supply, nor will it for a long time to come. It also appears, from this investigation, that the Asturians, although they demand to shut out foreign coals from Spanish smelting works on the eastern coast, dispose of the greater part of their own coals in foreign markets, by special privilege.*

The duty laid by Sir Robert Peel on the exportation of British coals, in 1842, proved a great benefit to the coal mining operations of Asturias, and gave a fresh stimulus to the miners of Gijon and Oviedo.† The influence effected by the removal of all duty, in 1845, will not counterbalance the heavy protective duty on the importation of foreign coals into Spain.

At the distance of nineteen miles, = thirty-two kilometres, from the port of Gijon, are coal lands of great richness, of which the products are of good quality. The bad state of the roads had rendered the working of the mines both costly and difficult. M. Aguado, formerly a banker of Paris, caused to be constructed a railroad from these mines to Gijon. The capital of M. Aguado's company is one million of pounds sterling. Coal can thus be transported at a low price to the sea ports. It was expected that it could be put on board ship at the ports of Gijon and Aviles, for from 13*s.* 6*d.* to 16*s.*, = $3.27 to $3.84, U. S., per ton. [This calculation was even over-rated, for subsequent experience has proved that it is sold on the coast of France for 12*s.* 6*d.* only, = $3.02 per ton.] Heretofore, the fuel brought from Asturias to Bilboa cost 6 or 7 reals the 50 kilogrammes, = 3*fr.* 16*cts.* to 3*fr.* 68*cts.* the 100 kilogrammes, = £1 8*s.* per ton, English, or $6.75. This mineral substance during combustion, exhales no odour, and the quality is equal to any which has been found in France, notwithstanding the owners of workshops in Biscay have not long employed this coal. Possessing still considerable forests, notwithstanding the ravages which have been caused by civil war, they find it more to their advantage to employ the timber in their forges than to sell their wood. Besides, the method employed there for working iron, renders it more malleable, and places it even in rivalry with that of Sweden.

According to a report of M. Landrin, a French engineer of eminence, upon the coal-field of Riva de Sella, in the Asturias, in 1842, the cost of extraction at the mines of Convera, and placing it on shipboard, was 4*s.* 2½*d.* per ton; and of the coal from the mines of Pacheo, 4*s.* Another estimate in the same year made the actual cost on board 5*s.*, = $1.20 per ton.

The proposition to form an uninterrupted line of railroad from the Atlantic to the Mediterranean, passing from the port of Aviles, in the Bay of Biscay, by Leon and Madrid, seems to have been favourably received.

The quantity of coal estimated to be capable of being furnished by the Asturian collieries on this line, is 400,000 tons per annum; the revenue from which to the railroad is estimated at £120,000. This coal is now being transported, *via* Aviles, to the ports of Santander, Bilboa, Corunna, and Vigo, on the north coast, and to Bayonne and Bourdeaux, and the *free* ports of Havre and Nantes.

The Northern Railroad traverses the great Asturian coal-field for nearly forty miles. This coal-field is the largest in Europe, and is destined to be the Wales of Spain. It embraces upwards of one hundred workable seams of bituminous coal, which vary from three to twelve feet in thickness. The

*** Mining Journal, August 5, 1843.**
† Observations on the proposed Duties on the Exp. of Coals, 1842, p. 17.

duty on the import of coal in English vessels is 12*s*. 8*d*., = $3.06 per ton, and 9*s*. 8*d*., = $2.34 in Spanish bottoms. Asturian coal, it is asserted, can be raised at a cost of about 4*s*., = $0.96 per ton; and, after paying all charges attending its transit from the most distant collieries to Aviles, it can be put on board at 12*s*., = $2.90 per ton, which is actually less than the import duties.*

The agent of the Asturian Mining Company communicates to his employers, dated Mieres, 17th January, 1845, that he could work out thirty tons a day, from two excellent seams, one of which is seven feet thick, for 2*s*. per ton, cost at the level's mouth.

At a meeting of stockholders of this company, 30th June, 1845, Mr. Pratt stated, from his personal observation, that of the one hundred coal seams that had been proved, most of them were, in his opinion, of a quality superior to that of France and Belgium, and fully equal to the coal of Northumberland and Durham. The measures, in approaching the coast, were comparatively inferior, yet they were still useful for household purposes, and also for the manufacture of coke.

Among the documents published by the Minister of Agriculture and Commerce of France, in 1845, is one referring to the coal trade of the Asturias. We observe that among the mineral products of this country, coal is the chief object of attention, and excites a high degree of speculation. In 1843, there had already been granted fifty-one concessions, of which three only were proceeding with more or less activity. These were the mines of Lagones, those of Aviles, and another, the Espada, situated upon the route from Oviédo to Léon.

The mines of Lagones produced, during the year 1843, about 40,000 quintals, = 2721 tons. Those of Aviles yielded about 250,000 quintals, or nearly 17,000 tons.

Besides the amount of coal annually derived from the various concessions, there are, at the same time, considerable quantities raised from localities out of the limits of those establishments, estimated, in the aggregate, at 200,000 quintals more.†

A report, by Mr. Colquhoun, was made to the stockholders of the Asturian Mining Company, in June, 1845, at the meeting previously mentioned, from which it appears that two railroads were then in progress of construction, from the collieries down to the coast; and it was anticipated that in 1846 there would be completed on the one side a railroad of ten miles, reaching from the mines to the port of Aviles, in the Bay of Biscay; and on the other, a railroad of about the same extent, to the vicinity of Oviedo, the capital of Asturias.

Coke has become a subject of first necessity in the manufactures and workshops of this country; and the company had already contracted with the government foundry at Trubia, to supply it with 100,000 quintals.

A correspondent of the Mining Journal, May 3d, 1845, remarks that the sinews of the future importance of the Asturias are in her quarries of iron stone and her beds of coal. He quotes from a work of M. Shultz, Director-General of mines, on the coal formation of this region, thus:—"The coal basin of the centre of the Asturias forms a most extensive group, having more than sixty distinct seams, generally of the very best quality, approaching to a vertical position, and extending several leagues, at a con-

* Articles in Mining Journal, March, 1845.
† Documens sur le commerce exterieur, Aout, 1845.

siderable elevation above the neighbouring rivers. It may fairly be called inexhaustible, for many ages, even should the exportation amount to a million of tons per annum."

The engineers of the Asturian Mining Company report that "the extent of this coal formation far exceeds that of Staffordshire or Wales. In length it reaches from the frontiers of France to those of Portugal, and in breadth it is at least eight or ten miles; and, probably, much more. In addition to the principal coal-field, there is another coal formation, more limited in extent, but of very inferior quality, much nearer the sea, at Arnao, a little to the west of Aviles, at Ferroues, and at Sante Firmé. There are many more similar small basins along the coast, namely, close to Gijon, at Vinon, near Villaviciosa, and between Infiesto and Las Arriandas. These collieries yield a description of coal unfit for metallurgical purposes or steam navigation, but suitable to lime burning, fixed engines, and for common purposes. They cannot come into competition with English coal.

The Pyrenean coal-field approaches the coast of the Asturias in the shape of a horse-shoe, between the ports of Villaviciosa and San Esteban.

The first division of the Asturian coal-field, is about seven miles long and eight or ten miles wide; containing upwards of 100 seams of coal, which differ in quality. A small fraction of the coal-field, which is worked, contains 30 feet of coal in 120 yards of ground, and have an average height of 150 yards above drainage level. Thus, 50 acres of ground alone contains 3,000,000 tons of coal. To the north-west of this colliery we have three other seams of coal, together twelve feet thick. To the south-east, there are 23 more seams, amounting to about 78 feet in thickness. At Lama there are 44 seams of coal, together 120 feet thick, that crop out in about 700 yards of ground; and this is not a tenth of the breadth of the coal-field. The coal is worked much cheaper than in England or Wales."

Mr. M. Forster, coal mining engineer, estimates 12*s*. 6*d*.= $3.02 as the obtainable price for the best of these coals, on board, as far north as Ushant, on the French coast, where it will be met by the coals from the north of England and Belgium, and extending west and southwards, along the whole of the north and west coast of Spain, and the coast of Portugal.

Port of Gijon.—Previously to 1844, the transportation of coal, coastwise, to various ports of Spain, from hence, was almost entirely performed by foreign vessels, chiefly those of France, under the Spanish flag.

The number of vessels engaged in this service, together with the amount of the trade sent coastwise, was as follows:*

Years.	Vessels.	Registered Tonnage.	English tons. †	Value Sterling.	Value in Dollars.
1839	25 Fr.	2483			
1842	60 Fr.	6400	14,100	£9,295	$44,467
1843	60 Fr.	6600	14,370	9,700	46,400
1844	{	French	23,030	14,550	69,590
		Spanish	18,370		

Another statement, said to be on authority of the mining department of Madrid, assigns 665,817 quintals, of the value of 1,997,451 reals, as the amount of coal raised in Spain, in 1844.

* Documens sur le commerce exterieur, August, 1845.

† The quintal of the Asturias, by which coal is sold, is 69 kilog. or 152 lbs.; being 14¾ quintals to 1 ton. The quintal Macho of Biscay appears to be used in the sale of iron, and weighs 77½ kilog.

Anthracite is stated to prevail in the Asturias, and examinations are going on, for the purpose of proving the extent and value of those deposits.

"*On the Coal Deposits of the Asturias.*"—This is the title of a paper submitted to the meeting of the British Association, in 1845, by S. P. Pratt. It is the result of a section passing to the coast, by Oviedo from Leon.

Coal beds are not seen to the south of the Pass, with the exception of one bed of nine feet, until near Pola de Lena, about four leagues beyond. From hence, towards Oviedo, in a distance of ten miles, more than seventy seams of good workable coal are crossed; beyond which the limestone rises from beneath the coal measures.

Near the upper part of the coal series, a bed of conglomerate occurs; and next the lower part of the same series is another conglomerate, probably exceeding 1500 feet in thickness. One good coal seam occurs in this conglomerate, and two or three below it.

It appears, therefore, that, besides extensive coal beds corresponding with those of England and other countries, this province possesses a considerable deposit belonging to an earlier period.

Iron Ore.—Connected with the coal, and always below it, are several beds of hœmatite iron ore, one of which is extraordinary, the pure unmixed ore being fifty feet thick, and extending for a considerable distance. From its mineralogical character, it appears to have been a mechanical or aqueous deposit.*

It would seem, from the various developments which have been already made in this region, and which we have detailed at considerable length, progressively, that the coal-fields of Asturias are likely to be hereafter ranked among the most valuable in Europe; and that they are destined to exercise a powerful influence on the industrial prosperity of Spain.

CATALONIA.

Bituminous Coal Basin of Ripoll.—A small quantity of this coal was exported into France in 1838, in the department of the Pyréneés Orientales. This is one of the small coal-fields which are inclosed within the chain of the Spanish Pyrenees, at a short distance from the French frontier. The working of this basin, and of those of Durban and Ségure in the French department of Aude, situated in an analogous position, serve also to develope the mineral deposits in the adjacent departments of France.

There are many places in this province which produce coal: eight localities have long been known.

In 1845, the mining engineers of France examined the working of the coal deposits of Ogassa and Surroa, near Campredon, in Catalonia.

The Pyrenees, both in Spanish and in French Cerdagne, possess deposits of tertiary lignites in fresh-water formations. Near Senabastre and Livia these beds occur; and, according to Mr. Lyell, lignite is still procured from pits at the former place. It occupies a basin or longitudinal valley, running east and west, and reposing horizontally in a depression of granitic and schistose rocks. The breadth of this fresh-water formation is about five miles; its length is not mentioned.†

Cupriferous Lignites in the Spanish Pyrenees.—Mr. W. E. Logan mentions a mine near Marc Anton and Heehas, to the west of the Urdax and Canfranc road, which presents a combination of coal and grey sulphuret of

* Report of the British Association for 1845.

† Proceedings of Geological Society of London, Vol. II. p. 21.

copper; occupying the forms of vegetable remains, in a regular eighteen-inch bed, which crops out all around a considerable mountain.*

Aragon.—Three principal points, where coal exists, were mentioned twenty years ago; but, owing to the domestic troubles of the country, mining has almost been abandoned.

BASQUE PROVINCES OF BISCAY PROPER, GUIPUZCOA AND ALAVA.

Province of Biscay.—Coal prevails in this province, where there are 80 to 100 iron forges, each on a small scale, employing only four or five men to each; but they have not hitherto used coal as fuel. Water is the motive power, and steam engines are unknown.

Stone coal could not be employed in the forges of these provinces, which forges are all built on the Catalan method. However, the country possesses mines of coal, which would be worked if high furnaces existed. But as the iron ore is not found in the proximity of the coal mines, the scarcity, and the difficulty of the means of transport, prevents the proprietors from drawing any advantage from the coal beds that are already known.

There is not in all Biscay a single high furnace. The iron which is produced here is sent, by land and by sea, to other provinces of Spain; some to France and England, and an inconsiderable amount to Cuba and Porto Rico.

	Produce. Quintals of 155 lbs.	Tons.	Tons.
In 1802, there were 180 iron works,	80,000	= 5830	32 each.
In 1826, " 117 "	45,000	= 3113	26 each.

We collect from the official returns the following details of the production of iron here, in 1843–4, but the table is incomplete.

Basque Provinces.	No. of works.	Tons produced.	Workmen.	Value.
Biscay proper, Bilbas, Catalan forges and foundries, of which 80 are in operation,	90	6000	360	£131,000
Alava, Vittoria,	50	"	"	"
Guipuzcoa, St. Sebastian,	44	2700	438	42,440
Kingdom of Navarre, Pampeluna,	22	"	"	"

All the Basque forges employ the iron ore of Somorostro, where, in 1843, there were extracted 587,000 [quin. m. ?] of ore for their use; of the value of £30,300, and employing five hundred workmen. This ore produces one third of metal. The greater part of the manufactured iron is employed in these provinces: the surplus is sent to the West Indies, France, and the rest of Spain.

During the civil wars, the iron works of the country were destroyed or suffered to pass into decay. Those unhappy times having now terminated, the burned and ruined forges have been repaired, and many of them are once more in activity. In 1844, the number had increased, and occasioned a corresponding demand for fuel. The consumption of the ore of Somorostro was about 70,000 tons.

In the spring of 1846, it was anticipated that several new high furnaces would be put in operation in Spain, some of which will employ mineral coal for fuel.

* Geological Report of the Canadas, May 1st, 1845, p. 64.

The iron of Biscay cost about 24 francs the quintal macho, of 77½ kilogrammes; = 314 francs, = £12 15s. per ton.*

Important deposits of coal at Tudela.

COAL IMPORTATIONS.

Valencia.—Value of coals from England, 1843, £3,040; 1842, £11,400.

Province of Murcia, in Valencia.—⅞ from England, ⅛ France, 1844, £3,100.

Province of Leon, in Old Castille.—On the frontier, adjoining Asturias, are good coal mines.

Estramadura.—Coal is mentioned here, but like the iron mines is neglected; the roads being of the worst description, and, in bad weather, are impassable.

Galicia.—It appears, beyond all doubt, that Galicia contains mines of coal, although they are almost entirely neglected.

There are numerous forges and high furnaces, but not hitherto worked with mineral fuel.

Andalusia contains ancient mines, both of coal and iron ore, which have been greatly neglected. Both mining and agriculture have, for a long while, been in a very backward state.

Province of Seville, in Andalusia.—In 1845 there were two coal mining establishments returned in this province, as in active operation; although they were not upon a large scale. They gave employment to 24 workmen, whose average wages per day were 1 fr. 75 cents, = 1s. 5d. English, = 34 cents United States currency.

New Castille.—Coal is worked to a small extent. Numerous beds are reported to exist in the provinces of Madrid and Cuenca; but the want of canal navigation or railroad communication, renders the transportation of the mineral fuel too expensive for consumption at Madrid, where fuel is one of the most costly articles of life.

Old Castille.—Coal in the province of *Segovia.*

In the province of *Santander,* in 1844, were 45 Catalan forges, employing 228 workmen, and producing 2200 tons annually, with the help of charcoal, of the value of £60,000. Important beds of coal occur here.

PROVINCE OF GRENADA.

A Lacustrine basin of the tertiary period; lignite or brown coal deposit of Baza. Deposited unconformably upon nummulite limestone and other rocks; its lowest diameter being about thirty-five miles.†

Another basin of brown coal, in this province, occurs about fifty miles to the south-west of that of Baza. It occupies a circular area, whose greatest diameter is thirty-six miles, and whose smallest diameter is about thirty miles, forming an area of about seven hundred and fifty square miles, English. Its geological position is between strata of gypsum and marl, and a fresh-water limestone. Beneath this limestone is a large deposit of brown coal, of an unknown depth. The fossil planorbis is abundant in its upper layers.‡

English coal imported into this province in 1843, 12,000 tons, valued at £24,250; Spanish coal brought coastwise from Asturias and Old Castille, in 1843, 9,007 tons.§

* Documens sur le commerce extérieur, June 1844—also August, 1845.

† Described by Col. Silvertop, Phil. Mag. and Ann. of Phil., Vol. VII. p. 453.

‡ Proceedings Geol. Society, London, Vol. I. p. 216, 1829,—also described by Col. Silvertop.

§ Documens sur le commerce extérieur, 1845.

Lignite.—About 200 tons were raised in Spain, in 1844.

Turf.—The works undertaken for the fortifications of Gijon, in Asturias, have discovered around that place, a thick and extensive body of peat.*

BALEARIC ISLANDS.—[BELONGING TO SPAIN.]

Majorca Islands.—Among other formations are those of beds of coal, with seams of clay-slate; overlying grauwacke. The colliery of Benisalem, opened in 1838, is now in good condition, and furnishes its products to the shores of the peninsula of Spain. Concessions have been obtained, for the working of two mines of coal, which have been discovered in the interior of this island.†

Amount and value of coal and iron produced in Spain, in the year 1844, published by authority of the mining department of Madrid:

	Spanish quintals.	Eng. tons.	Value in rials.	Value Ster.
Bituminous coal,	665,817	30,264	1,997,451	£21,971
Brown coal,	10,900	495	327,000	140
Iron, cast and wrought,	572,441	26,020	30,963,785	444,042

The average quantity of iron made in Spain, about the year 1828, was 8,000 tons annually. Raw iron, 252,000 quintals in 1842, = 17,380 tons.

Value of foreign coal imported into Spain in 1843, £43,290.

Observations.—It will be perceived that, with the exception of the recent operations in Asturias, our information, both in a geological and statistical sense, in relation to the Spanish coal-fields, is very defective.

Notwithstanding the unhappy political troubles with which that fair country has been so long afflicted, the operation of mining and smelting mineral ores, particularly iron, has, of late years, made considerable progress. This mining and manufacturing stimulus has led to a great demand for coal; and so large a trade has risen up, on the Mediterranean shore of Spain,—which, until lately, has been almost exclusively supplied by England,—that naval officers of that country were lately engaged in surveys, near Carthagena, for the safety of British collier vessels. Vessels from Liverpool, we are told, are continually arriving at that port, laden with coal, fire bricks, implements, machinery, &c.

The Spanish government was lately urged to exclude these English coals from the eastern smelting establishments, by means of a very high duty, and thereby to enable the coal owners of Asturias to furnish the quantity required. But the government decided that this measure would render the fuel too costly; and, further, that there was little probability, for a long time to come, that the Asturias coal mines could supply so much as is now annually consumed on the Mediterranean border. Even as it is, the import duty on coal is enormously high.

* Bulletin de la Société Géologique de France, tome X. p. 194.

† Faits commerciaux, 1845.

PORTUGAL.

Area of the kingdom of Portugal, 34,500 square miles. Population, 3,400,000 persons.

Tariff.

Duties on the importation of foreign coals and bituminous matters, also of exportation, according to the tariff of the 11th March, 1841; put in force on the 21st August, following.*

			Duties in French units.			Duties in English denominations.		
			Base.	Import.	Export.	Base.	Import.	Exp.
				Fr. C.	Fr. C.		s. d.	d.
Bitumens, Solid	Coal	Coal,	Tonneau	1.25	06	Ton.	1 2	¼
		Coke,	100 kilo.	4.26	21	Ton.	34 5¼	2
	Asphalt.	Jew's Pitch,	do.	10.21	04	Ton.	82 5	3¼
		Bit'us Stone,	do.	64	01	Ton.	5 2	1
	Succin. or Yellow Amber	Rough,	Kilogr.	1.63	01			
		Worked,	do.	21.79	07			
	Jet or Black Amber	Rough,		82	01			
		Worked,		10.89	07			
Bitumens, Liquid	Naptha, clear colour,			54	01			
	Petroleum, brown colour,			54	01			
Modification of the Tariff of 1841. *Put in force, Feb.* 13, 1844.								
Coke or carbonized coal, - -			100 kilo.	32		Ton.	2 7	2
Coal dust, - - -			Quintal.	1.06		Ton.	8 6¼	
Scoria or Cinders, - - -			do.	11		Ton.	10	1

By a supplement to these tariff laws, the following directions are given for the *moneys, weights, and measures.*

Real of Lisbon = 00.625c. being equal to 480 reis for 3 francs or 160 reis for 1 franc.

Real of Madeira = 00.54c.

1 League = 6 kilom. 174 = 6751 yards, Engl. = 3 miles and 1471 yds.

1 Vare = 5 palms = 1 mèt. 100 = 3 feet, 608 = 43½ Engl. inches.

Tonneau of solidity = 1,065 cube metre = 37,612 cub. feet, Engl. = 30¼ bushels.

Tonneau of freight = 18⅜ quintal = 1,092,879 kilog. = 2405 lbs. = 1 ton and 165 lbs.

A pipa of coal is 16 fangas = 128 alqueires; which, at 2½ alqueires per bushel, is 51½ English bushels.

*** Documens sur le commerce extérieur, Juillet, 1844.**

Province of Beira.—Here a mine of coal has for some time been worked.

Near Oporto.—Anthracite.—On the south borders of the Douro, overlying primitive rocks, is a conglomerate formation, consisting of fragments of granite, gneiss, and chlorite slate. Alternating with beds of this conglomerate are seams of anthracite; and the series appears to be overlaid by chlorite slate, in which occur veins of metalliferous quartz, containing ores of *silver* and *antimony.**

Beds of *lignite* are described by Mr. D. Sharpe, in 1840, in ferruginous sandstone, in the cliff of Cascaes Bay, near the mouth of the Tagus. The quantity is too limited to become of value as a fuel. Lignite also prevails at Torres Vedras; at Cape Espichel, and Aganheira.†

We simply note them as geological facts.

Asphalt.—A mine has been discovered in the neighbourhood of Alcobaça, of a good quality of asphalt, and a company is formed for the working of it.‡

Coal imported from Great Britain into Portugal.§

Years.	Tons.	Years.	Tons.
1831	6,402	1836	14,669
1832	7,509	1837	20,966

Our knowledge of the coal formations of Portugal is very scanty. We have seen it noticed, obscurely, that coal, in considerable quantity, really prevails in this country.

Depots of English coal are established at Figuieres, at Coimbra, and near Oporto.

* Mr. D. Sharpe, in 1832. Also McCulloch, Gazetteer.
† Trans. Geol. of London, Vol. VI. p. 117.
‡ Mining Journal, Jan. 1, 1845.
§ Parliamentary Records. Tables of Revenue and Commerce of the United Kingdom.

NORTHERN ITALY.

PARMA.

Naphtha.—The use of this substance was known to Pliny. During the Roman period, the poorer classes made use of this material to supply them with light; and even in our day, the city of Genoa in Parma, is illuminated with the Naphtha of Amiano. Herodotus speaks of the springs of bitumen which existed in the marshy plain of Forto Cheri.*

The principal coal mines of Italy, which produce annually from 140,000 to 150,000 quintals, are in the Savoy, and near Genoa. The others, scattered over the Peninsula, are of little value.

There are depots of English coal at all the principal ports.

For details relating to Lombardy, Sardinia, Savoy, Piedmont, &c., see under the head of "Austrian Empire."

Duchy of Modena—Petroleum Springs at Saint Zibio.

Monaco Principality, under the protection of Sardinia. An earthy coal, probably a lignite, occurs at Menton, and is described by M. Diday.†

In the Appenines are some good coal mines, of no great magnitude Anthracite also occurs.

Valley of the Po.—Large deposits of lignite coal prevail.

SOUTHERN ITALY.

SICILY.

Messina.—A bed of *lignite* very near Messina, to the left of Fort Gonzago, about three or more feet thick. It was applied by the English troops during their occupation of Sicily, to culinary purposes; the cavalry used it in their forges, and the country people for burning lime.‡

* Office de Publicite, also McCulloch's Dictionary of Commerce.
† Annales des Mines.
‡ Papers Geological Society, London.

Amber, probably of the same geological age, occurs disseminated in beds of clay and marl, which lie below the formation, which correspond with the *calcaire grossier*, or London clay. The amber is accompanied with bitumen, and though a scanty deposit, is mined for sale. The pieces are coated with a kind of whitish bark, presenting a variety of colours, and including many insects.* It is met with on the banks of the river Giaretta.

The following notice, respecting the discovery of coal, was in general circulation in 1847.

Discovery of Coal in Italy.—Operations have been recently undertaken in the valley of Torrino, a province of the Abruzzo di Teramo, for the discovery of fossil coal. The depth of the excavation is at present 240 feet, but the workmen have not succeeded in discovering the desired carboniferous strata. The combustible materials, however, hitherto discovered, are of excellent quality, and contain hydrogen and carbon in abundance, with a small proportion of sulphur. The comparative tests applied show that this material is not at all inferior in quality to the coal of Newcastle.

Val di Noto—Petroleum Springs.

CALABRIA.

A coal-field exists, approaching to within four miles of the sea. Seven seams of coal have been traced here, along their outcrops. Two only of those seven have been heretofore worked. France and Malta are looked to as markets for the sale of this coal. The worked seam is about four feet thick. The cost of raising it was not more than 10*s.* per ton. We have no decided information further.

NEAPOLITAN DOMINIONS.

A coal-bed, of extraordinary richness and purity, has been lately announced.

NAPLES.

Petroleum springs arise from the bottom of the sea, near the southern base of Mount Vesuvius.†

Coals, Culm and Coke, imported from Great Britain.‡—In the year 1836, 20,642 tons; in 1837, 20,801 tons; in 1838, 26,709 tons; in 1844, 65,003 tons; in 1845, 97,338 tons.

TUSCANY.

Fossil coal is now ascertained to exist here. Near Monte Bamboli and Monte Mazo, there is a coal formation which has given rise to a long conflict between science and practice. From the examination of the first specimens, the savans declared that this substance was not true coal—"charbon de terre"—but a lignite of little value.

Whilst the academy at Florence was deliberating the matter, the men of business put in motion a steam boiler with the same specimens of the fuel. Pressed by experience, science hastened to declare that this lignite was so perfect that it was equivalent to the coal of Newcastle, of the second quality. A French and Tuscan company has been formed, and the mine is in operation; the beds appear to be considerable.

* Ure's Dictionary of Arts.
† M. Brieslack.
‡ Parliamentary Records.

The fabrication of iron—the ore of which is brought from the Isle of Elba to Tuscany—will receive a great impulsion when the working of the coal mines of Monte Bamboli shall be in full activity. The proprietary mining company here has lately voted the necessary funds for the construction of a railroad, designed to convey the coals extracted to the place of embarcation.*

THE PAPAL STATES.

The annual export of charcoal is 3,000,000 lbs., = 1340 tons.†

We know but little of the mineral productions of the Roman states.

Coal is supposed to exist at Beracqua, Pesaro, in the territory of Sogliano, and other places. Large pieces were found in 1778, and several attempts were made to explore the mines, but it is still doubtful whether they consist of true coal, or anthracite.

Geological explorations have been for some time making in these wealthy but enslaved states. As regards their mineral resources, they have been greatly neglected heretofore, but it has been announced, lately, that coal exists therein. In 1847, valuable discoveries of coal and iron ore are announced in various parts of Italy, particularly in Sardinia, along the Appenines, and in the Abruzzi, and companies are forming to work them on a large scale. These undertakings have met with the greatest encouragement from the high authorities; and the last though not the least important one, is his holiness, Pope Pius IX.

A ton of coals from Newcastle costs at Civita Vecchia from 35 to 40 francs.‡

* Documens sur le commeree exterieur, Juin et Juillet, 1845.
† Parliamentary Records, Bowring's Report.
‡ Bulletin of the Minister of Agriculture and Commerce, Paris, 1841, and 1842.

IONIAN ISLANDS.

ZANTE.

There are no known indications of coal, but petroleum and tar-springs, occur somewhat similar to those of Trinidad. The following notes are derived from the statistical work of Mr. R. M. Martin.

As the substance called *asphalt* is coming into use, it may be stated here that the valley or marshy plain, containing the bitumen at Zante, is the segment of a circle, surrounded on three sides by abrupt and rugged ridges of hills. In the marsh within the circle are several wells or pits. The bitumen floats on the surface of the water in these wells. A dark substance continually forces its way from the bottom, and boils up in large globules, which enlarging as they ascend till near the surface, then burst and liberate a quantity of inflammable gas. Sometimes the globules are transparent and of singular brilliancy; rising to the top and bursting, while a coat of dark bituminous matter, in which they were invested, is thrown off. This dark substance is the *petroleum* or *rock-pitch*, which being specifically heavier than water, remain below, covering the sides and part of the bottom of the spring. The brilliant globules, disengaged from it, are pure *naphtha* or *rock-oil*, which forms a light oleaginous stratum above; reflecting various beautiful colours. The intervening water is sweet and fit for use. The pitch is collected with large spoons into a pit adjoining the well, and thence thrown into barrels. It is exuded in the greatest quantities in the summer months. About a hundred barrels are annually used for paying the bottoms of ships and for similar purposes.*

* Colonial Statistics of the British Empire, Martin, p. 592. H. E. Strickland "on the Geology of Zante," Geol. Trans. 1837. Also Dictionary of Commerce, 1839.

GREECE.

This monarchy contains 10,206 square miles. Population 810,000 persons.

EUBŒA, OR NEGROPONT.

Lignite.—The deposit and working of the lignite in this island formed the subject of an examination by French mining engineers, in 1845. There are abundaut seams of brown coal here, as also at Ellis.

The Quarterly Journal of the Geological Society of the date of February 1st, 1847, contains an account of the lignite beds in the Kastrovalla Valley, in Eubœa, by Lieutenant Spratt, R. N. This valley, like that of Koumi adjoining, is filled with a lacustrine deposit of the Escene period. This formation is remarkable for a bed of lignite. The coal, we are informed by the author, has been tried in some of the steamers, and burns well, but is objectionable on account of its emitting a disagreeable smell, and producing a large quantity of dirt or ashes, in proportion to the fuel consumed.

This lignite bed consists of four seams, included in a depth of about sixteen feet. The thickest seam is four feet, and the others are from one to two feet each; they are separated by a black clay and dark indurated marls. The lignite is thinly laminated, and contains no vegetable impressions: it varies in character, from a woody texture to a tolerably brittle coal. The bed was discovered about fifteen years ago, in consequence of a land slip, at the head of a ravine leading up from the valley of Koumi.

The Greek government has, until lately, procured a considerable quantity of coal from this spot; a tunnel with a train-way having been carried horizontally into the seam for several hundred feet: but the expense of carriage has discouraged the continued working of the mine, since the material is found not to be economical for steamers. It is principally used in factories.*

BŒOTIA.

Near Markopoulo, on the eastern side, opposite to Eubœa, is another fresh water deposit, resting upon mica schist, which is also described by Lieutenant Spratt in the article last quoted. Its area does not exceed seven miles in length, and contains a similar bed of lignite.

The coal of this district was only discovered about the year 1845, and is worked with some activity; it being more easily procured and at a shorter distance from the sea than the Koumi coal.

The mine is situated at the head of a narrow valley behind Markopoulo. The lignite here is found lying near the surface; the superior strata having been denuded down to it. When visited by the author, a portion of the uncovered lignite was burning, from spontaneous ignition. This bed is about eleven feet thick; thinly laminated throughout.†

* Quarterly Journal of the Geol. Soc. of London, No. 9, p. 68, 1847. † Ibid. p. 70.

SAMOS.

A prolongation of the same fresh-water formation, above mentioned, occurs in this island. Lieutenant Spratt does not describe any decided bed of tertiary coal, but notices the abundance of vegetable impressions. A species of reed often occurs in clusters, like a number of cylindrical pipes of one and a half inches in diameter; their cavities not being filled by the calcareous matter after their decomposition. They are nearly always found in a vertical position; some of these stems have leaves attached to them. There are also impressions of leaves resembling those of the oleander.*

GRECIAN ARCHIPELAGO.

Island of Candia or Crete, Mediterranean Sea.—Politically this island lately belonged to Africa, as forming part of the Egyptian state, but is again under the Turkish influence, and belongs to the Grecian Archipelago. Two coal mines have been discovered in Candia; one upon the north coast, about four hours journey from Retino: the other upon the south coast, at Preveli, near Spakia, a short distance from the sea.

In May, 1839, fifty quintals of coal were raised from the first named mine, by order of the governor, Mustapha Pasha, and were sent to Egypt.

A new survey having been demanded, 1363 quintals, of 221 pounds English each, or about 135 tons, were raised in ten days, and forwarded to Retimo on the backs of asses.

The coal mine of Previl, to the east of Spakia, is at a distance of only about a hundred yards from the sea. The specific gravity of this coal is, however, below the usual average.

The governor of the Ionian Islands, announced his intention of going to examine this coal on the spot.†

The knowledge of the coal of Candia did not reach Dr. Bowring, whose report, dated March, 1839, states that "nothing whatever has been done, in the way of inquiry for mines or minerals."

As to coals, it appears from the most recent return in 1837, there was an import into Crete from England, of 630 tons at thirty-two shillings, amounting to 1008 pounds.‡

In February, 1840, some coal, the produce of the two mines above mentioned, was essayed in one of the steamers belonging to the French squadron in the Levant. The sample from the mine at Retimo was chiefly in a pyritous state, and that from Preveli in a ligneous state. It seemed to be the opinion, that these mines might be advantageously worked, and at the same time would add to the revenue of the island.§

In the absence of any geological information, we should infer from the slight notices here collected, that one or both of these coals may belong to the class of brown coals.

It does not appear by the commercial statistics of the year 1844, that coal formed an article of export from this island.||

Malta.—Importations of coal from Great Britain in the year 1844, 48,546 tons; and in 1845, 52,327 tons.

* Quarterly Journal of the Geol. Soc. of London, No. 9, p. 65. † French papers.
‡ Report on Candia to Parliament, by John Bowring, 1839, p. 163.
§ Mining Journal, vol. x., 347. || Documens sur le commerce extérieur, June, 1844.

EUROPEAN TURKEY.

This empire contains 210,000 square miles. Population, 14,500,000 persons.*

Province of Albania.—The asphaltum mines were celebrated in the time of Pliny. This substance occurs, in large deposits, in sandstone.

Importation of coals from Great Britain into Turkey and Greece, besides a few tons annually from Belgium: in 1844, 34,448 tons; in 1845, 56,776 tons.

OTTOMAN EMPIRE.

Wallachia or Valachie, in European Turkey, but under the Protection of Russia.—Not far from Tchernetz, the tertiary beds present the appearance of a pseudo volcano, in which the lignite deposits exhibit spontaneous combustion, by the decomposition of sulphuret of iron. This combustion occasions a crateriform subsidence. The clay and the sand, altered by the fire, form scoriaceous masses; stony, and even so vitrified as to produce a sort of jasper porcelain.†

Coal.—Several beds occur in the mountainous parts of Wallachia, towards the northern boundary formed by the primitive Carpathian mountains.

Lignite, Bitumin, Asphaltum, Amber and Fossil Wax, occur in the supercretaceous formations of the plains.

Naphtha or Petroleum springs also prevail in this province.

Moldavia—Principality, united with Wallachia.—Coal in the bordering Carpathian mountains. Also lignite and bitumen in the plains, similar to Wallachia.

Crimea.—See Southern Russia.

Servia.—Coal occurs in this principality, but few or no mines are worked; it being part of the policy of the government to conceal, rather than develope, the resources of the provinces.‡

Roumelia.—Coal occurs in the north side of Constantinople.

Bulgaria.—Coal occurs in this province, but is not employed in any important extent.

Thrace—Lignite.—On the western shores of the Black Sea, in Thrace, Professor Hitchcock mentions an interesting and extensive deposit of lignite. This bed is stated, on the authority of Mr. Homes, to be five miles long, and from three to ten feet thick. From the characters of the clay

* Official Belgian Commercial Returns.

† M. Huot, Bulletin de la Soc. Geol. de France, Vol. X. p. 153.

‡ McCulloch.

and limestone in which the lignite occurs, there can hardly be a doubt, that the whole is of the tertiary age. In its vicinity is a protrusion of trap, which may be even more recent than the lignite.*

From the *western banks of the Bosphorus*, Professor Hitchcock has been furnished with specimens of true coal, which appears to be identical, almost, with the bituminous coal of Heraclea, on the south coast of the Black Sea, in Anatolia,† of which an analysis is given by the Professor.

Sea of Marmora.—In the same vicinity of the Bosphorus, lignite occurs. A bed of lignite was discovered by Edhem-Bey, at Rodosto, on the north shore of the sea of Marmora: a specimen of this lignite has been in the museum of the Geological Society of France, for more than forty years.‡

* Trans. Association of American Geologists and Naturalists, 1843, p. 392.
† Ibid. See Heraclea, in Anatolia.
‡ Bulletin of the Geological Society of France, Vol. XI. p. 278.

SWITZERLAND.

Area of the Swiss Republic at the end of 1837, 15,233 square miles. Population 2,188,000 persons.*

This country receives from the east of France a small supply of coal. In 1839, 5,150 tons.

It also imports some coal from England.

The only coal mine of any value in this country is at Hochefeld. In 1843, it produced 514,969 quintals.

It abounds in tertiary lignite, at St. Gallen and other places.

In a bed of brown coal at St. Gallen a new species of combustible mineral was found by Captain Scheerer, after whom it has been named Scheererite.†

The microscopic examination of this lignite proves that it contains the wood of conifera.‡

Neuchatel.—Petroleum springs.

Asphaltum occurs in parts of Switzerland.

Canton of Zurich.—The tertiary coal seams are remarkable for the many bones of Mammifera discovered in them, among which are those of the Mastodon.

Canton of Lucerne or Luzern.—At Alpnach, near the Lake of Luzern, a remarkable coal formation occurs, at the depth of two hundred and eighty feet below the surface. Over this coal seam is a stratum of bituminous limestone, containing fossil shells, and bones and teeth of the large mammalia, among which are those of the Mastodon.

Notwithstanding these fossil remains, immediately overlying the coal, yet it approaches in character very nearly to mineral coal, and the strata of micaceous sandstone and shale above it, have a close resemblance to those of the English coal-fields. Although from the organic remains, we are obliged to place the coal of Alpnach among the tertiary strata, yet Mr. Bakewell hesitates to define the true geological position.§

The lignites which are found in the basin, separating the Alps and the Jura, at Vernier, Pandex, Vevay, near the Lake of Zurich, at Œningen and elsewhere, including all the steinkohles of Switzerland, appear to be deposited in fresh-water lakes, in ancient times.||

Mr. Murchison described the Lacustrine deposit of Œningen in 1829. It contains numerous plants, insects, reptiles, fishes, birds, and the remains of a carnivorous animal. The fresh-water strata rest upon a tertiary marine formation, and all the circumstances attending this deposit possess the highest interest.¶

* McCulloch's Dictionary. † Brewster's Journal, Allan's Manual of Mineralogy, &c.
‡ Annales des Mines, M. Link, 1840. § Bakewell, 3d edit. p. 173.
|| Dr. McCulloch, Journal of Science and the Arts, Vol. XX.
¶ Proceedings Geol. Soc. of London, Vol. I. p. 167.

AUSTRIAN EMPIRE.

Area in all 164,715,520 acres, 257,368 square miles. The Provinces which contain coal or lignite, 96,000,000 acres, 150,000 square miles. The latter is only an approximate estimate. Population in 1838, 35,670,996 persons.

Weights, Measures, and Money.

The Austrians, Hungarians, and Galicians, use the same standards, in most respects.

Measures of Length.

The German mile = 8101 English yards, = 7,407 French kilometres, = 4 miles 1061 yards English, 21,725 German miles to 100 English miles.

The Vienna foot = 12.45 English inches, = 3.161 French decimetres.

Weight.

The centner or quintal, or cwt. of Austria or Vienna = 123½ lbs. English; therefore there are 18.2 cwt. to 1 ton English. (100 livres) = 56 kil. 00.12.

The scheffel of Prussia is 110 lbs., being about 20 scheffels or quintals to 1 ton English.

The Vienna lb. = 1.235 lb. avoirdupois.

The Livre de Vienne = 0 kil. 56.

The commercial Last, = 2905 kil. 6000 lbs. weight, = 2⅔ tons English.

16 German Loths = 1 Marc = 7oz. 2dwts. 4grs. Troy.

Measures of Capacity.

The Vienne Metzen, = 3753 cub. Eng. inch. = 1.745 bush. = 61.496 Fr. litres.

The Metz of Gressburg, dry measure, = 1.745 imperial bushel English.

The Koretz of Galicia = 123 litres = 3.3 imperial bushels.

The Last of Hamburg for grain, &c., contains 11.2 Winchester quarters, = 99,540 cubic feet, = 88 Winchester bushels.

The Joch, or Austrian acre, = 1.46 English acre.

1 Oke = 43.3 oz. avoirdupois.

1 Centner or Quintal = 44 Okes.

1.785 quintals of wood = 1 French tonne.

Currency.

Gold Coinage.—The Souverain, 3 dollars 38 cents 7 mills United States,

Double Ducat, 4 dollars 59 cents 3 mills United States. Hungarian Ducat, 2 dollars 29 cents 7 mills United States. Gold Ducat of Kremnitz = 4½ Florins = 6*s.* 6*d.* English = $1.57.

Silver.—The Austrian, Hungarian, Frankfort, Nassau, and Rhenish florin is = 60 kreutzers = 15 batzen = 2*s.* English = 2 francs, 61c. = $0.48 United States.

9 florins and 35 kreutz. = £1 English at par = $4.84, or 4*s.* 8*d.*

1 Livre di Milano was introduced by the French = 1 franc = 22.8 kreutz.

1 Austrian Lira = 100 centimes = 0 fr. 87 cts.

Par value in London of £1 sterling, 9 florins, 50 kreutz. of Vienna.

The Convention florin of Hesse Darmstadt, Bavaria, Baden, and Holland, is = 1*s.* 8*d.* English, divided into 60 kreutzers.

The Vienna florin = 2 francs 59c. = 2*s.* 1*d.*

1 franc of 1809 = 9¾*d.* English.

5 francs = 4*s.*

Copper.— Austrian,
- 1 Grosh, $0 3cts. 14 — American currency.
- 1 Gould, 51 85
- 1 Rexdollaar, 77 77
- The Kreutzer, 0 francs 87 cts. = $0.008 U. S.

Official return of the average annual quantity of coal produced in the entire Austrian Empire during the five years preceding 1835, and in 1843 to 1845. There were neither imports nor exports of coal recorded during this period.

Production of Coal in the Austrian Empire.

Provinces.	Quintals of 123 lbs.	Tons of 2240 lbs.	1845. Quintals.	Tons.
Upper Austria,	245,180	13,621	1,550,000	85,164
Lower Austria,	22,646	1,258		
Styria,	329,054	18,281	1,000,000	54,945
Carinthia, and Carniola, and Istria,	49,614	2,756		
Illyrian Coast, Dalmatia,	35,668	1,981	550,000	30,220
Tyrol,	39,935	2,219		
Moravia and Silesia,	465,664	25,870	2,030,000	111,538
Bohemia,	2,213,095	123,950	6,200,000	340,656
Galicia,	176	10	3,000	170
Lombardy,	33,441	1,857	65,000	3,571
Venice,	1,997	111		
Hungary,	342,573	19,032	602,000	33,076
Average of five years, 1830 to 1834,	3,779,043	209,946	12,000,000	659,340
Total in 1843,	9,000,000	440,620		
" " 1844,		531,000		
" " 1845,	12,000,000	659,340		
" " 1846, estimate,		700,000		

The Mining Journal of 28th of March, 1846, contains an article on the metallurgic industry of Austria. This country possesses extensive coal beds, but the working of them has not yet been carried to any extent, there being a great abundance of wood, and at low prices. Notwithstanding this, wood within the last few years has become scarcer; indicating that trade, generally, is improving, so that the State and the large proprietors of mines must shortly make exertions to produce the mineral fuel in greater quantities.

At the last exposition, about fifty of the exhibitors sent to Vienna samples of coal, anthracite, and lignite. The annual production of coal in Austria, during late years, is estimated at 600,000 tons, and recently upwards of 700,000.

Tariff of Import, Export, and Transit duties, levied in Austrian Empire on sea coal—whereby it appears that the high Import duty was equivalent to a prohibition:

In Austrian Money and Rates.				In English Money and Rates.			
Unit of charge.	Import Duty.	Export Duty.	Transit Duty.	Unit of charge.	Import Duty.	Export Duty.	Transit Duty.
Per Gross Centner of 123½ lbs. Eng.	*Fl. Kr.* 15 0	*Fl. Kr.* 0 25	*Fl. Kr.* 0 2	123½ lbs.	*L. s. d.* 1 10 0	*L. s. d.* 0 0 10	*L. s. d.* 0 0 0.45

Exports of Coal from the Austrian Empire.

In 1844, from Bohemia, by the Elbe, to Saxony, 703,262 quintals; to Turkey, 25,433 quintals; to Southern Germany, 23,210 quintals; to Prussia, 20,542 quintals; small exports, 616 quintals; total, 773,065 quintals.

Prices of Fuel in Austria in 1846.

	Per Centner.	Per Ton of 2240 lbs.	
		English Shillings.	U. States Dollars.
Coal of Moravia, for Steam Engines,	46 Kreutzers,	28s.	$6.62
Upper Austria, do. do.	36 do.	25	5.08
do. coal of the first quality for forges,	60 do.	36	8.64
do. second quality,	57 do.	34	8.16
do. Charcoal.	60 do.	36	8.64
do. Lignite,	26 do.	15.6	3.75

Wood.—Although beds of coal have been found in nearly every Austrian province, the abundance and cheapness of firewood have hitherto prevented much extension of exploration. The forests are computed to cover more than a third part of the productive soil of the Empire.

The number of acres of forest land in the Austrian Empire, is 43,896,637. Annual produce in cubic Vienna fathoms, 17,126,823; besides that of Hungary, about 7,000,000—total, 24,126,823.

From these forests, 200,000 bushels of gall apples are annually exported, besides those used in the country.

LOMBARDY IN ITALY.

Gulf of Venice.—Lignites passing into coal beds, occur abundantly in a formation corresponding with the oolitic era, in the Island of Veglia, and at Carpona, where they are excavated for the use of the Trieste steamboats.

The iron foundries of Lombardy are situated on the borders of immense forests that cover the mountains, and furnish a cheap supply of fuel.

There is a small quantity of true coal also raised in Lombardy, the annual average of which during the five years preceding 1835, was 1,857 tons; that of Venice, at the same time, was 111 tons = 1968 tons; in 1845, 3,571 tons.

MILAN IN AUSTRIAN ITALY.

Peat employed as fuel for railway locomotives.—An experiment has been tried on the railway, of nine miles, from Milan to Monza, where coal cannot easily be procured, and peat turf has been substituted with success, and with a saving of thirty to forty per cent. on the cost of fuel.

KINGDOM OF SARDINIA IN ITALY.

This country receives a small supply of coal from the South of France. In 1839, 5,910 tons.

Peat.—In Sardinia, where coal is rare and costly, railways find resources in the numerous peat bogs of the country.

DUCHY OF SAVOY, OR SAVOIE.

Coal Mine of Entreveines near Annecy.—This mine occurs, according to Mr. Bakewell, in a mountain valley, about two thousand feet above the Lake of Annecy, and at least three thousand five hundred feet above the level of the sea. The seam of coal contains about four feet of workable good coal, having the character and fracture of mineral coal. It is shining; does not soil the fingers; and is highly bituminous; being exclusively used for the gas lights in the cotton mills at Annecy.

The total thickness of the coal measures here, is about four hundred and fifty feet, placed between thick beds of limestone, and dipping at an angle of about seventy degrees. The age of this limestone is that of the English lias, and the coal is not older than the imperfect coal of the oolitic age.* After the investigation of M. Gras, it is probable that this, like other coal formations bordering the Alps, does not, in fact, really belong to the jurassique period alluded to, but is merely covered by it. Yet it must be recollected that such a view is in opposition to that of M. Elie de Beaumont, as regards Savoy and the department of the *Hautes Alpes.*

MOUNT SAINT BERNARD.

In the Alps, anthracite, embedded in bituminous schist, occurs, containing numerous vegetable impressions. In the Little St. Bernard, anthracite occurs in the transition clay slate,—near the village of *La Thuile.* It is 100 feet long and two or three yards thick.† The coal burns with difficulty, and is used only for burning lime. There are several beds in that country, which extend down the reverse slope of the mountains, looking to Savoy. The slate inclosing them, presents vegetable impressions of equisetum or analogous plants, calamites, &c. Anthracite is mentioned, at other points.

* Bakewell, third edition, p. 172.

† Dr. Ure's Dictionary, p. 903.

Lignite basins in the environs of Chambéry.—Besides the consumption in the vicinity, they furnish a small supply to the neighbouring department of Isère, in France.*

Coal of the Cretaceous period, in the environs of Thonon, Savoy.†—This is a very bituminous coal, burning with a long flame, and emitting the characteristic odour of the lignites. The analysis by M. Gruner showed 22.10 per cent. of ashes. Of the remainder the proportions were,

Coke,	64.80
Volatile matters,	35.20
	100.00

PRINCIPALITY OF PIEDMONT.

Tertiary or Brown Coal, of the age of the Plastic Clay, at Cadibuona.—This coal contains bones of mammalia, similar to those in the coal beds of Upper Styria, at Scheineck. The lignites of the two places are undistinguishable, and occur in both at the base of the respective tertiary systems with which they are associated.‡

The Alps Coal of the Oolite age.—The rocks containing this coal, were described by M. Elie de Beaumont, and the coal plants were examined by M. Ad. Brongniart. Many of them were discovered to resemble those of the coal measures; but they still are associated with Bolemnites, both above and beneath them. It is unnecessary here to extend this notice with well known details. These may be consulted in the works of the above named authors, and in communications by various other geologists, such as Studer, Boué, Sedgewick, De la Beche, Buckland, Murchison, and many others of eminence.

TYROL.

Valley of the Inn.—Tertiary coal-basin, at Häring on the north flank of the Tyrolean Alps.

The dislocated secondary rocks which flank the Inn, on either side, are expanded between the towns of Rattenberg and Kaufstein, in such a manner as to leave between these two places an elliptical tertiary basin, about twenty miles in length, and four or five in its greatest breadth. It contains a mass of coal, of great thickness, which is extensively worked. A transverse section of this basin, illustrates the memoir of Messrs. Sedgewick and Murchison, on these and some other similar deposits, on the outskirts of the Austrian and Bavarian Alps.§

This coal is worked by adit levels, at different elevations, and the deposit gradually acquires thickness as it descends towards the centre of the basin. Thus the coal which had a thickness of twelve or thirteen feet in the higher works, near where the mineral rose to the clay on the mountain side, was found to have increased to twenty-five feet when the Franciséi-stollen was driven. At the Barbara-stollen, which is one hundred and sixty feet lower, it has a thickness of *thirty-four* feet; while at the level of the Inn, it has been proved, by actual boring, to be about *fifty feet* thick. It is

* Statistique de la France, 1839. † Annales des Mines, 1844. Tome II. p. 585.

‡ Sedgewick and Murchison, in Geological Transactions.

§ Trans. Geol Soc. London, Vol. III. second series, p. 368. The authors also quote the detailed history of the works, by Professor Flürl of Munich, in his "*Steinkohlen Gebirge vo Haring.*"

estimated that the greatest thickness of the tertiary group, which encloses this coal, is not less than seven or eight hundred feet, comprising indurated marl, conglomerates, calcareous sandstones, bituminous marlstone, and lithographic stinstone, forming the roof of the lignite.

The miners distinguish four varieties of coal here.

1. *Pech kohle*, colour velvet black, and with little bitumen—Pitch coal.
2. *Schiefer kohle*, slaty coal.
3. *Schuppen kohle*, a variety resembling cannel coal.
4. *Glanz kohle*, approaching to anthracite or coke.

At the Barbara-stollen gallery, where, as we have stated, the coal is thirty-four feet thick, more than two-thirds is of good quality, and is largely extracted for the use of the salt-works at Halle near Inspruck. It contains both iron and copper pyrites, in the upper beds.

From the general character of the marine shells which accompany these coal strata, some of which shells have been identified with those of the London clay, the authors last quoted are disposed to refer the whole deposit to an early part of the tertiary period.*

Valley of the Lech.—Seventy miles nearly west of the Häring coal basin, and twelve miles north of Fussen, occurs a group of strata, consisting of micaceous and calcareous sandstones, grits, and marls, and a seam of coal about three feet thick. From the general position of this group, and from the analogy of other sections, Messrs. Sedgwick and Murchison think it undoubtedly belongs to the tertiary system. The authors observe, that lignite is, by itself, no test of the age of any tertiary deposit; inasmuch as we have on the northern skirts of the Alps, two or more courses of that mineral, one in the lower and another in the higher part of the series, separated from each other by vast sedimentary formations. Without assuming the former continuity of distant deposits of lignite, they think it evident that these were developed through a considerable extent of the lower tertiary groups, between the Lech and the Inn; for, in addition to the localities above mentioned, we find traces of them at Pensberg, a few miles north-west of Benedict Bayern; at Tölz, on the right bank of the Isar, and at Parsberg, near Miesbach, all which places seem to be nearly on the same parallel. The map which illustrates the memoir referred to, shows twenty-nine positions where coal is or has been worked, on either side the Alps.

Wood and Coal.—Average annual produce of coal mined in the Tyrol during the five years preceding 1835, 2219 tons. The forests, which amount to 2,767,496 acres, furnish annually 932,000 cubic fathoms of wood.†

* Proceedings of the Geol. Soc., Vol. I. p. 157.

† McCulloch's Gazetteer.

ARCHDUCHY OF AUSTRIA.

The following table shows the amount of coals annually raised from the mines of Upper and Lower Austria, during the five years prior to 1835. The quantity is thought to be greatly under-rated. There appears to be no distinction made in these returns, between true coal and lignite.

The principal port in the archduchy is Trieste.*

The area is 8,259,631 English acres.

Production.

Years.	Upper Austria.		Lower Austria.		Total.
	Vienna quintals of 123 lbs.	Engl. Tons of coal.	Vienna quintals of 123 lbs.	English Tons of coal.	Tons.
1830	19,793	1,100	243,405	13,522	14,622
1831	28,230	1,566	178,565	9,920	11,486
1832	12,950	720	214,045	11,891	12,611
1833	22,136	1,229	231,020	12,834	14,063
1834	30,120	1,673	358,865	19,937	21,610
1845					85,164

Lignite.—At Grünback a species of coal occurs, accompanied with fresh-water shells, tertiary fossils, nummulites, and corals.

Basin of Vienna, in Lower Austria.—Our authority respecting the coal formation of this tertiary area, is again the indefatigable authors of the memoir last referred to, who further cite the details of M. Partsch. The whole group is nearly horizontally disposed, and consists of about eleven hundred feet in thickness of loam, called *löss*, gravel, sands, fresh-water limestones, white marine coral limestones, calcareous conglomerates, breccià, calc-grit, blue marl, &c., &c.,—abounding in terrestrial shells, fresh-water shells, marine shells, bones of elephants, mastodon, anthracotherium, tapir, stag, and other mammalia; corals, &c.

This tertiary range is situated between the Danube and the northern skirts of the eastern Alps; but it does not abound as much in wood coal, as does the Styrian tertiary basin.

Near Mölk on the southern border of the Danube, about two hundred feet above the level of the river, a bed of lignite occurs, but is too poor to remunerate those who have attempted to work it.

There are some other positions more to the south, marked upon the author's map, where brown and black coal are worked, but are not specifically detailed in the memoir.

The age of this Vienna and the Styrian basins, is determined to be about coeval with the middle and higher sub-appennine formations, while the lowest groups, chiefly in Styria, are compared with a portion of the deposits in the London and Paris basins. At Penitz, near Vienna, lignite is worked as coal

Valley of the Danube.—Immense beds of brown coal prevail. The imperial coal mines of Moldwa, on the banks of this river, supply the steam navigation of the Danube with fuel.

* McCulloch's Gazetteer.

PRINCIPALITY OR PROVINCE OF TRANSYLVANIA, ADJOINING TO HUNGARY.

No coal raised or returned separately in the public reports. Brown coal occurs.

"An explanatory sketch of a geological map of Transylvania" has been published by Dr. Ami Boué. The author describes tertiary formations containing lignite, like those of Hungary.*

Marshal Marmont states that coal, of very good quality, is found in some parts, but it is not made use of.† Petroleum abounds.

PROVINCES OF MORAVIA AND AUSTRIAN SILESIA.

According to M. Sternberg, the coal formation of Silesia, which stretches the length of seventeen leagues, reaches Schatzlar in the Reisengebirge on the one side, and Schwadowitz in the lordship of Nachod, in Bohemia, on the other.

Mr. Boué describes two coal-fields in the basin of the Oder.

The annual average of coals produced in these provinces, during the five years preceding 1835, was 465,664 quintals or centners, = 25,870 English tons. In 1845, increased to 2,030,000 quintals or centners, = 111,538 English tons.

In the brown coal of Wolchou, in Moravia, occurs the variety of mineral resin denominated retinite or retinasphalt.‡ Mr. Boué states that lignites and retinite characterize the green sand formation at Obora. The former are covered with oysters and serpulæ, and are often pierced by the Teredo.

PROVINCE OF AUSTRIAN CROATIA.

Coal is one of the chief mineral products of this country, but we have no details at hand.

PROVINCE OF DALMATIA, ON THE NORTH-EASTERN SHORE OF THE ADRIATIC.

Coal is found in several parts, and considerable quantities are exported to Trieste. Near the coast the forests have been nearly all cut down: in the interior are 394,580 English acres of excellent timber, yielding annually 252,060 cubic fathoms of wood.

Bituminous Limestone.—Bitumen is so abundant in certain limestones of Dalmatia, that the rock may be cut like soap, and is employed in the construction of houses; for which purpose, when finished, the walls are set fire to, the bitumen burns out, and the stone becomes whiter. The roof is afterwards put on, and the house completed.§

* Proc. Geol. Soc. Lon., Vol. I. p. 243.

† McCulloch, Art. Transylvania.

‡ Allan's Manual of Mineralogy.

§ Allan, p. 36.

KINGDOM OF ILLYRIA,—[Established in 1815,]

INCLUDING THE PROVINCES OF CARINTHIA, CARNIOLA, AND ISTRIA.

The average amount of coal raised in Carinthia and Carniola, in 5 years prior to 1836, 49,614 cwts., = 2756 tons. Coal produced on the Illyrian coast, 35,668 cwts., = 1,981 tons. In 1837, produce of the coal mines of Illyria, in cwts., the Austrian or Vienna cwt. being 123½ lbs. English, = 18.2 to 1 ton, 92,653 cwts.,=5,147 tons. In 1845, 550,000 cwts., = 30,-220 tons.

Peat also abounds in some parts of *Illyria.*

Timber in Northern Illyria.—The forests, in 1837, contained 2,140,520 English acres; yielding on an average, an annual supply of 1,132,600 cubic fathoms, or toises, of wood, consumed.

Southern Illyria contained 444,144 acres, and supplied annually, 264,-040 cubic toises.

In Istria, are lignite beds of the oolite age, passing into coal at Carpona and in the island of Veglia, where they are wrought for the use of the Trieste steamboats.

CARINTHIA.

Wood is employed in making iron here, as in Styria and Hungary.

The wood employed is principally the *pinus picea,* silver fir, and the *pinus sylvestris,* Scotch fir or pine. They are selected from among other resinous or coniferous trees. Of the other descriptions of wood, with which experiments have been made, is preferred the birch, which gives a long and abundant flame, and is used to great advantage: but the oak, the beech, and the other leafy trees, are less preferred to the resinous woods, because they do not give so long a flame.

The process of making iron by means of wood for the fuel, is evidently susceptible of application in all those countries where wood is at a low price, and where it can be transported to the iron works at a small cost. It is desirable that this should be composed of the resinous trees. Consequently, that system of iron making will be most appropriate to the northern countries, which abound in that description of timber.*

STYRIA.

Carbonized wood employed in iron making.—This country abounds in iron works, in some of which wood is the sole fuel employed, and in other works they mainly use peat. Notwithstanding the number of high furnaces in this region, timber is still very cheap. In the mountains and the gorges of Styria, adjoining the archduchy of Austria, the timber consists of the resinous kinds, and principally *pinus picea,* the silver fir; *pinus abies,* spruce fir; and *pinus larix,* or larch, and occasionally the beech; but non-resinous trees are rare.

The two first are almost solely employed in the numerous works of all this portion of Styria. In general, they do not carbonize the larch, because it gives a charcoal of indifferent quality. In the refining hearths, the char-

* Sur l'emploi du bois et de la tourbe dans la métallurgie du fer, Annales des Mines tome II. p. 379.

coal employed is about equal proportions of that prepared from the *P. picea* and from *P. abies*.

The following table, furnished by M. A. Delesse, exhibits the weight of these combustibles; the quantity being one solid stere, = 35¼ cubic feet English.

Timber.	State.	Kilogrammes.		Engl. lbs.
Pinus picea or silver fir,	Green,	581	=	1278
	Dry,	499	=	1097
Beech,	Green,	1002	=	2204
	Dry,	807	=	1775

The carbonization is performed after the ancient method of the forests, in rectangular stacks; producing 48 to 54 per cent. of charcoal, weighing 144 kil. [= 316 English pounds,] each cubic metre [= 35¼ cubic feet,] equivalent to 9 lbs. to each cubic foot.

Wood is very abundant in all this portion of Styria, notwithstanding the great number of iron works which we find. Thus, Forderberg, which is only a few miles distant, has 17 high furnaces assembled at one point; and at every quarter of a league one meets with forges of iron or steel.

After having felled the wood upon the planes of the gorges, the logs are made to slide down to the foot of the mountain, where they fall into the water courses, which then transport them, floating, to their destination. The corded stère costs at the furnace, 2 francs 20 cents, = 1*s*. 7*d*. English, = $0.38.*

The desiccation of the wood is the next process; which is accomplished by two methods; one in the open air, the other in ovens. That being effected, the wood is ready for use in the iron works, such as the puddling furnaces, in manner detailed by M. Delesse.

In Hungary and Carinthia they have also adopted the same system as prevails at Newberg, &c., in Styria, above indicated.

Some of the Styrian furnaces work with warm air and some with the cold blast.

The province of Styria is the central point of the iron mines of Austria, where the mountain of Erzberg displays its magnificent summits, 4800 feet above the level of the sea, and contains the richest iron mines in the Empire. At the foot of this mountain is the town of Vordenberg, where are fourteen large foundries, the proprietors of which have united themselves in one co-operating firm, which is now able to furnish nearly all the rails required for the works of that country.†

LOWER STYRIA.

Brown Coal.—Vast beds of lignite occur in this province, whose geological age is subsequent to that of the chalk formation. There are many valuable mines of that fuel. It is assigned to the geological period of the plastic clay.‡

There are various beds of brown coal or lignite near Eibeswald.§

Coal.—The average amount of coal raised annually, for the five years

* The Corde of wood in France varies in bulk, but in general is 2¾ stères, which is about 100 cubic feet English. In America the cord is 128 feet:—in England the same, but seldom used.

† Mining Journal, 30th May, 1846.

‡ Dr. Macculloch on Lignites, Quarterly Journal of Science and the Arts, Vol. XX.

§ Proceedings Geolgical Society of London, Vol. I. p. 218.

previous to 1835, was 329,054 quintals or cwts.=18,281 tons. In 1845, 1,000,000 quintals or cwts.=54,945 tons.

Wood.—Number of acres of forest land in Styria, 2,523,008 English acres. Annual produce of the same, 1,820,234 cubic Vienna fathoms. Much wood is used in iron making in Styria.

Basin of Gratz, [*Capital of Styria,*] in the valley of the Mur and its vicinity.

In 1833, an account was published of "the occurrence of bones of animals in a coal mine in Styria," by Professor Anker, of Gratz. The coal referred to occupies a range of hills near Gratz, extending from the Schwamberg mountains to Scheineck on the Weiss.

The beds of brown coal are from two to two and a half feet thick, closely resembling black coal in appearance, and only distinguishable from it by geological position, and by the occasional occurrence of the woody texture.

The bones are found in the coal itself, in layers from two to two and a half inches thick. They appear to have belonged to many different animals, but are too much shattered to enable an accurate opinion to be formed of the genera to which they were allied.

Messrs. Sedgewick and Murchison notice several interesting deposits of brown coal, which we can but briefly advert to here. They occur in the upper portion of the great tertiary basin of Hungary.

Of the coal beds skirting the flank of the Schwanberg Alp, that at Scheineck is the most interesting, on account of its organic remains. Here the coal is extracted from the base of an escarpment by horizontal galleries, which follow the line of deposit. The coal itself is about three feet thick. The shale in which it is embedded contains arundinaceous plants, while shells, fossil fish, and mammalia are associated with the coal.

In certain laminæ of the coal, a passage is, here and there, seen from wood, with a dicotyledonous structure, into mineral charcoal: in other laminæ, the coal appears to have resulted from the compressed leaves: in those parts which enclose the bones, it is nearly in a state of jet.

The shells agree with those found in the *calcaire grossier* of Paris, and in the London clay.

Near Gratz are numerous beds of brown coal, two to two and a half feet thick; closely resembling the black or hard coal, in appearance, and can be distinguished from it only by geological position, and by the occasional occurrence of the woody texture. In this coal we remark the unusual phenomenon adverted to above; that is to say, the presence of bones of various animals. Amongst these is a species of anthracotherium, the teeth of hyenas and sharks; scales of fishes; fragments of mammalia, and tortoises; shellfish, &c.*

At *Voitsberg*, fifteen miles west of Gratz, at *Lankowitz*, and many other parts of Styria, lignite, of different structure, occurs in more recent tertiary beds than those enclosing the last mentioned series. Several small basins are formed in the valley of the river Kainach, as it descends eastward from the Pach Alp. The lignites, which are therein accumulated, are nothing more than brown coal in its first state of carbonization, the woody structure being still preserved; in which respect they resemble the brown coal of the Rhine, of Hesse Cassel, and of Bovey, in England. To the Bovey coal they are also analogous in containing no traces of any animal remains, marine, fluviatile, or terrestrial.

* Trans. Geological Society of London, 1829 and 1834.

The most important of these deposits, at Oberdoff, near Voitsberg, has at one place a thickness of *seventy-two feet*, and is worked in a lofty, subterranean chamber, seven hundred and twenty feet in length. It is in parts very pyritiferous. This brown coal occurs at very different levels; being at Lankowitz several hundred feet higher than at Oberdorf.*

KINGDOM OF GALICIA.

EASTERN PROVINCE OF THE AUSTRIAN EMPIRE.

But a small quantity of coals is returned: only ten tons in 1834, and one hundred and seventy tons in 1845. There is said to be an abundance, and that it occurs in many places: but as the greater part of the secondary formations are covered by the immense bed of sand, which forms the Polish plain, it is not easy to ascertain their exact nature, nor what minerals they contain.

Wood.—This country is in some degree compensated by the quantity of forest: the number of acres of which, returned, in 1837, at 6,046,143 English acres

The annual yield or consumption being 2,423,689 cubic toises.†

Petroleum or Naphtha springs.

KINGDOM OF HUNGARY.

Estimated area, 106,359 square miles.

The resources of the country, although abundant, a very little understood. Considering the metallic wealth of the Hungarian mountains, the production, as shown by the official returns, is astonishingly low; more especially as relates to iron and coal.

In the extensive sandstone hills, which stretch from the Dunajec to the Transylvania frontier, coal beds occur, and with these are large quantities of the carbonate of iron.‡

* Trans. Geological Society of London, 1829 and 1834. † McCulloch. ‡ Ibid.

	Centners of 123½ lbs.	English Tons.
The annual average of coal raised in the ten years, from 1819 to 1828,	264,358	14,516
In the five years, from 1829 to 1834,	342,573	19,032
Districts of Neusohl and Banat, in 1838,	392,912	21,828
" " " 1845,	602,000	33,076

Mr. Payet considers that the Hungarian coal is equal to the English, for all manufacturing purposes.

The *Carpathian* mountain range contains large fields of coal, which will be separately noticed.

Buda—Royal free city of Hungary. The lignite mines are remarkable for the supply of fuel which they afford, and possess considerable geological interest.*

Slavonia, or Sclavonia, Province of the Austrian Empire in Hungary. Coal is affirmed to exist within its limits, probably of the age of the brown coal.

KINGDOM OF BOHEMIA.

Area, 20,285 square miles, English.

Production of true Coal.—Coals are abundant, being exported to *Leipsic* for railroads and steam engines, also to Nuremburgh, for the railway between that place and Furth. It is also sent to Magdeburg and Dresden, and to Munich and Augsburg. Add to this, it goes to Lintz in large quantities for the use of the steam navigation on the Danube.

When railroads increase, the export of coal will also be far greater, as Bohemia, in this respect, is favoured above its neighbours. At the same time it must be recollected that this country is abundantly supplied with wood; the annual yield of the forests being estimated at two millions of cubic fathoms.

One coal-field in Bohemia occupies a length of fifteen leagues, and a breadth of from four to five leagues.

Coal occurs in several districts in the western part of Bohemia. The main basin of Bohemia is a very extensive district, including the adjoining part of Upper Silesia.

On the south-west, the coal appears to form a number of small and detached basins, scattered along the line of the Beraun.

On the north-west, towards Silesia, the coal district becomes more continuous and extensive. It is associated with porphyry, as in the neighbourhood of the Hartz and Saxony.

* Quarterly Journal of Science and the Arts, Vol. XX.—On Lignites.

More than forty seams of coal are worked in this country. There is a basin near *Prague*, and coal mines at *Plaven*.

Professor Ansted, in 1839, reported to the Geological Society of London, on the coal deposits between Prague, Luditz, and Pilsen. They occur in disconnected patches, overlying the grauwacke rocks,—also in the circles of Klattan, Beraun, and Rakowitz.

At Pilsen, workable seams of coal occur. Twelve miles east of this, at Radnitz, two coal bands are worked, and to the north of the latter is a broad valley of coal measures. Eastward, near Przilep, two or three tolerably thick beds of coal are worked, and supply Prague with fuel. At Radnitz, before mentioned, the flora of the coal measures is well known to be rich, and to have yielded those fine fossil plants which are described by Count Sternberg, in his magnificent work.*

Dr. Buckland has, in his usual felicitous style, given us an eloquent account of the fossil vegetation of the Bohemian coal formations. These coal plants are there seen in extraordinary beauty, development, and preservation.†

Periodical production of Coal in Bohemia.

	Centners.		Engl. tons.
Average of five years, from 1829 to 1834	2,213,095	=	122,950
1836	3,000,000	=	165,082
1839	4,000,000	=	220,110
1845	6,200,000	=	340,656

At the present date, 1846, the rich coal mines of Bohemia are being worked to great advantage. The iron manufactures connected with them are most flourishing, and the demand for iron is daily increasing. In 1843 Austria produced 2,720,000 quintals of rough and cast iron, being about one-twelfth of the quantity furnished by Great Britain.

There are now two hundred high furnaces in Austria in operation.

In the production of cast iron in Bohemia, they generally employ turf mixed with charcoal, and the amount of metal has doubled within the last ten years.

M. M. Chevalier‡ states, that Bohemia has received from nature a bountiful distribution of the combustible minerals. She possesses a considerable extent of coal lands: she has, in addition, in immense quantities, a very fine lignite. She presents also anthracite, and deposits of peat deserving attention.§

There may be distinguished in this country, particularly in northern Bohemia, two zones of coal formations, differing in general character from each other. They occupy, the one the east, the other the western part of this northerly portion of the kingdom. Their separation is formed by mica schist and transition schists.

* Proceedings Geol. Soc. London, Vol. III. p. 165.

† Dr. Buckland's Bridgewater Treatise.

‡ Sur les richesses de la Boheme en combustibles fossiles, et sur le bassin houiller de Radnitz en particulier: P. M. M. Chevalier, Ingénieur en Chef des Mines. Annales des Mines, 1842.

§ We may add also great store of plumbago,—from the domain of the Prince Schartzenberg, in Budweis, where there is a bed three to six yards thick, in gneiss From 1830 to 1834 were drawn annually a million of kilogrammes, = 1000 tons, which were sent to Hamburg, and thence to England. In 1835, 42,359 quintals or cwt. of 123.4 Engl. lbs., = 2,350 tons, the production of the Prince's mines. In 1840, 14,000 quintals only, the trade with England having greatly fallen off, and her supply being now chiefly from Spain.

EASTERN BOHEMIA.

According to M. Chevalier, in the eastern zone, the coal resides in the middle of the grès rouge, or rothe todte liegende, which, according to some geologists, is of the same age as the coal formation, properly so denominated. In the western division the coal is contained in a series of small basins, which belong especially to the known coal formation.

I. This author proceeds to describe the coal region contiguous to the Prussian frontier. Within the limits of Bohemia, this zone occupies fifty or sixty miles in length, from east to west, and thirteen to sixteen miles in breadth, from north to south. The coal is principally worked at Schlatzlar and Nachod, where the seam is more than six feet thick. It extends eastwardly into Prussian Silesia, fifty miles further, where are the rich deposits of Neurod and Waldenburg.

The six feet bed above mentioned, is especially adapted for conversion into coke. By analysis of Professor Balling, of Prague, the coal consists of 78.8 per cent. of coke; but this coke contains 20.3 per cent. of ashes.

II. Thirty-two English miles to the south-east of the basin just described, around Karzim, is another area occupied by the grès rouge coal formation. It is nine miles from north to south, and six miles from east to west. The coal dips at an angle of at least 29°, and not being thick, has not yet been worked, or considered sufficiently encouraging.

III. Another detached area in the same direction, occurs at Landskron; but little seems to be known respecting its coal.

WESTERN BOHEMIA.—BITUMINOUS COAL.

This division presents the richest portion of coal, contained in three principal basins, besides several smaller ones. They are as follows, in the descending order, from north to south.

IV. *Basin of Rakonitz.*—From east to west this basin is forty English miles, and from north to south is ten to twelve miles. There is reason to think that, at certain points, it may be prolonged some distance further, in both directions. This coal basin has been pierced by basalt in some places, particularly at Schlan and Winarzitz. The coal has been most successfully explored between Buschtiehrad and Schlan. The two beds principally worked are each more than six feet thick; separated from each other by five feet of shale. The lowest bed is the best, if not the only one adapted to make coke. The amount raised is already very considerable. Its destination is for the consumption at Prague, and of the manufactories which adjoin the mines. Within a short time persons have been engaged in making researches, and have discovered coal in a great number of points and workable positions. It is inexpedient to give the details of these here.

Prof. Balling states that the Buschtiehrad coal gives 80 per cent. of coke, and 7 per cent. of ashes.

V. *Coal Basin of Radnitz.*—This appears to be a small basin within the limits and in the middle of the vast basin last described. Its form is irregular, and it is estimated to contain 45½ square kilometres, = 4,550 hectares, = 11,230 English acres.

This little coal-field contains, in proportion to its extent, considerable riches. There is found one bed of ten metres, [nearly thirty-three English feet,] apparently horizontal, remarkably regular, and very easy to work, on account of the consistence of the coal. It is pure, easily lighted, burning with a long flame, without giving out that fœtid odour which belongs to

many coals;—several of those of Saint Etienne, for instance. It is rather pyritous, although not distinguishable to the eye. It is, in fact, a superior coal for the grate, but not proper for making coke. Mr. Balling found it to possess 40 per cent. of volatile matter, and that it only left 1.34 per cent. of ashes.

In the "*exploitation*" of St. Joseph, at Wranowka, the bed presents itself at the depth of 25 to 45 metres, = 81 to 147 feet. It possesses a remarkable solidity and regularity. The galleries are at least thirteen feet, and often twenty feet wide, and as many high. At some points there are crossing places forty feet wide, and notwithstanding the extraordinary breadth of these spaces beyond what we commonly meet with in coal works, in no part is there any timber to sustain it. Near a large crossing way M. Chevalier remarked a pillar which had only at its end a thickness of *0m. 65a.*, = 25 inches: and observes that he knows no coal mines which present any thing like such an economy of wood, or which even approach, in this respect, what is seen here.

The usual power of the bed is about thirty feet. In this power occur three or four little courses of fine grained sandstone, about a third of an inch thick, and easy to separate from the coal. The roof, which is immediately over the coal, is a fine grained solid sandstone, and this is the main cause of the facility for making the galleries of such extraordinary dimensions.

In the mine they fall the coal in large blocks. The merchantable coal is extracted by the cube metre, [= 35*ft.* 287*d.* Engl. feet, cubic,] weighing 964 kilogrammes, [= 2,120 pounds, or not quite a ton] each. The difference between the absolute weight of a metrical cube and the foregoing productive weight, arises from the waste and the fine coal which is left at the pit's mouth; at present unsaleable or of small value. The price at the mine is

6*fr.* 30*c*,, = 5*s.* 6*d.*, = $1.33 per ton for the large coal,
and 4 50, = 3 7, = 0.90 " " medium size.

This arises from the low price of extraction, which costs only 2*fr.*, = 20*d.*, = $0.40 per ton. By deducting the cost from the mean selling price of the coal, it will be seen that the gross relative profit, without making other obvious deductions, is about 150 per cent. But the absolute profits are modified further by charges not common to other coal countries. Among these must be reckoned one which is rather heavy; for in Bohemia the mines are subject to a right, on the part of the lord of the soil, of a tithe of the produce: that is to say, for every ten tons which are brought to the surface, it is necessary to remit him one.

This price of labour in this region is low; the miners receive at the rate of 1 franc, = 9¾*d.* English, = 19 cents American currency, per day. It has been as low as 52 centimes per day; which is scarcely more than half the recent prices, above named; or 10 cents per diem.

VI. *Coal Basin of Pilsen.*—To the west of the small, but rich basin of Radnitz, is the great basin of Pilsen. In a north and south direction this region extends thirty-one miles. The greatest breadth which it attains is rather more than ten miles. Its mean dimensions are about twenty by ten miles.

Several beds of coal have been worked here, for some years, from four to six feet thick; of a quality suitable for making coke. Smaller beds also occur.

The coal of Reschnitz, according to Professor Balling, yielded 65 per cent. of fine coke, and 4.70 per cent. ashes.

That of Wilkischen yielded from 54 to 63 per cent. of not very good coke, and 12 to 15 per cent. of ashes.

SMALLER BASINS OF BITUMINOUS COAL.

VII. *Basin of Przilep.*—Contained a coal seam six feet thick, but which is now actually exhausted.

VIII. *Basin of Iliscow and Stradonitz.*—At Iliscow a coal bed exists, of good quality, but of moderate thickness. At Lisek a coal bed has been exhausted.

IX. *Basin of Zebrak*, near Rokitzau.—No coal worked.

The coal of each of these little basins is not caking. In Bohemia this precious quality is a privilege reserved for the great basins, to the exclusion even of that of Radnitz.*

Terms of Concessions or Grants for Mining Coal.

According to the laws of Bohemia, the concessions of coal land, or of the right of working coal, are of a very limited extent. Each grant, properly speaking, embraces only a superficies of 425 metres by 126¼ metres, [= 464 by 116 English yards:] being an area of 4½ hectares [= 11⅐ English acres.] The depth of each original concession is also fixed, at 190 metres [= 207 yards.]

To acquire a grant of the mineral which is situated at a greater depth than this, it is necessary to reconnoitre the ground below that level. For a single shaft a concession may be obtained quadruple in area to the primitive concession; that is to say, the grant will extend over 425 metres by 425 metres; the new area being $18\frac{6}{10}$ hectares [or 44½ acres.] There is nothing to prevent, in Bohemia, several concessions being granted to the same person. As has been before stated, the coal mines are charged with tithe to the lord of the soil, of one tenth of every measure.

In France, we are told by Mr. Chevalier, it is customary to grant only a single concession, in the same coal basin, to the same person. But the extent of the French concessions, is, in general, infinitely greater than those of Bohemia. They are, also, unlimited in their depth. It is rare that the French concessions are less than some hundreds of hectares, of nearly 2½ English acres each. Those which extend back to an ancient date have a great number of square kilomètres [of 1093 yards.] There are coal concessions in France which extend over an area double that of the entire basin of Radnitz.

In Nassau.—Mine of New Hope, the royalty or rent $\frac{1}{84}$ of profit. Concessions of three kinds. See Nassau.

Fossil vegetation of the Bohemian Coal Mines.—M. Corda has discovered the leaves of a new species of Sigillaria, and describes them as linear, very long and narrow, from one to two feet long, and scarcely one line and a half broad, with a prominent rib along the middle. They have much resemblance to the leaves of *S. lepidodendrifolia*, and to those of some species of Lepidodendron. It has been suggested, as very likely, that some of the so called *Lepidophylla*, which occur very frequently in a detached state in the coal formation, may be the leaves of Sigillariæ.

Under the head of Palms, the most material novelty in the observations of M. Corda, is the discovery of wood belonging to this tribe, or at any rate to Endogenous class, in the coal mines of Bohemia. It occurs, only in small

* Annales des Mines, Vol. I., 1842, p. 589.

fragments imbedded in nodules of iron ore—Sphæro-siderite. This discovery is the more important, as A. Brongniart has lately denied altogether the existence of Endogens in the coal formation.

The coal and subjacent strata of Bohemia have also furnished M. Corda, with a rare species of Protopteris, [Zippea,] a great many genera of the groups or tribes to which he has given the names of *Rhachiopterides*, *Gleicheniaceæ*, *Schizæ aceæ*, &c. or ferns, of peculiar characters, and twenty-six species of the genus *Psarronius*.*

Increasing demand for Coal for domestic and manufacturing purposes.

Notwithstanding there are. in Bohemia, 3,393,215 acres of forest, which are estimated to yield annually 2,000,000 cubic fathoms of wood, yet the supply of timber is rapidly diminishing, and has become inadequate to the requirements of the country, particularly in the vicinity of the mines and factories. Consequently, the value of the mineral combustibles has augmented to a corresponding extent. The demand for wood is accelerated by the manufactories of sulphuric acid, already very numerous in Bohemia, and which are still multiplying. Other industrial operations, besides the domestic wants have also additional claims for fuel. The neighbouring forges, which are important, and of which the extension is only limited by the attainment of the combustible, will change infallibly, as has been the case in France, where they reserve the wood [charcoal] for fusing the minerals, and where they refine the castings or pig iron, by means of coal. As to domestic consumption of coal, the following official table will show its increase in PRAGUE, from 1830 to 1839, being 135 per cent. in ten years.

Table of the consumption of Fuel in Prague, from 1830 *to* 1839, *or ten successive years.*

Years.	Wood cordes of 88¼ cub. feet.	Charcoal in Fr. tonnes.	Coal in French tonnes.	
1830	57,097	566	10,515	The Austrian corde of wood is 88¼ cubic feet. The American cord is 128 cubic feet.
1831	46,019	496	10,538	
1832	44,241	631	10,973	
1833	51,371	571	11,313	
1834	92,102	600	13,698	
1835	44,965	677	14,801	
1836	36,235	665	15,989	
1837	48,698	710	16,459	
1838	46,370	710	18,996	
1839	46,162	884	24,255	

To this table we add another showing the description and quantity of fuel used at Vienna, for nine and one fourth years, from 1831 to 1840. It will be seen how trifling was the demand in a city of 400,000 inhabitants, at the commencement of this period, and how rapidly the consumption was increasing in the later years.†

* Quarterly Journal of the Geological Society of London, Vol. II. p. 119.
† Annales des Mines, Vol. I. 1842, p. 600.

Table showing the consumption of Fuel of all kinds in Vienna in ten successive years.

Years.	Wood Cordes.	Charcoal Tonnes.	Coal Tonnes.	Years.	Wood Cordes.	Charcoal Tonnes.	Coal Tonnes.	
1831	126,033	4,827	3,220	1836	127,282	6,339	4,614	
1832	103,883	4,338	3,189	1837	102,181	6,230	4,469	
1833	147,183	6,078	3,139	1838	130,267	6,860	7,013	
1834	113,271	6,306	3,469	1839	130,375	6,858	10,043	
1835	137,307	6,866	2,761	1840	101,673	6,067	7,342	3 months' coal.

By way of comparison as to the consumption of fuel in large cities, we add the following returns.*

Table of the consumption of American Fuel in New York, in 1832, and of Philadelphia, in 1833.

Fuel.	New York. 1832. Population, 223,000.				Philadelphia. 1833. Population, 210,000.	
	Number.	Denomination.	Mean price.	Value.	Fuel.	Value.
Wood,	265,192	Loads,	\$ 2.31¼	\$ 615,915	Wood,	\$ 741,321
Anthracite,	50,162	Tons,	10.65	513,797	Coal,	404,401
Virginia bituminous coal,	11,046	Chaldrons,	8.94	99,717		
Charcoal,	347,792	Tubs,	.28¼	100,078	Charcoal,	Not regist.
				\$1,329,507		\$1,145,722

The above table does not include the amount of foreign coal consumed in these cities.

The amount of coal brought into the Thames, and sold in the port of LONDON at this time [1832], was 2,139,078 tons: at least, equivalent in price to as many pounds sterling, and certainly not less than \$11,000,000: exclusive of all other descriptions of fuel.

Fuel consumed in New York, in 1836.† *Population,* 262,000.

Description.	Number.	Denominations.	Mean price.	Value. £ Sterl.	Value. Dollars.	Years.	Total Value consumed.
			L. s. d.			1830	\$ 814,817
Wood,	267,998	Loads,	0 11 7	155,554	752,800	1832	1,327,507
Anthracite, Pa.	15,858	Tons,	2 1 10	33,160	160,490	1833	1,127,430
Virg. Bit. coal,	6,453	Chaldrons,	2 0 0	12,808	61,990	1836	1,100,480
Charcoal,	291,886	Tubs,	0 1 9	25,248	122,200		
				226,770	1,097,480		

Fuel received on the Quays of Paris.—Population, 910,000.

	1838. Engl. Tons.	1840. Engl. Tons.	1844. Engl. Tons.	1845. Engl. Tons.
Coals and Coke,	139,197		197,220	216,747
Charcoal,		241,706		275,415

* Hazard's Register. † Journal Statistical Society of London, 1830.

Anthracite.—A little to the north-east of Budweis, there exists, in the gneiss, a small tract analogous to the old red sandstone of the English geologists, and which M. Chevalier considers as differing completely from the *grés rouge* of the French, and from the *roche todte liegende* of the Germans.

At Lohotitz, in this formation, well characterized anthracite has been recently recognized. But M. Chevalier regards it more in the light of a geological curiosity than as a deposit of combustible, from which a supply of consequence can be drawn. This bed attains, at some points, to five feet thick, but three-fifths of this thickness consist of a melange of shale and of anthracite, of no value.

In the exploration pits, visited by this author, the bed was only three feet thick, out of which the pure anthracite only occupied eight inches. The remainder is good, more or less, for burning with wood, in the stoves of the peasantry.

Lignite or Brown Coal.—If the deposit of anthracite possesses so little interest, it is quite otherwise with those of lignite. In this country they occur at the base of the tertiary formation; that is to say in the plastic clay which separates the tertiary series from the chalk, and which, more or less, in almost every known locality in the world exhibits vegetable remains.

The Bohemian lignite beds exist to the north of the coal formations, and form a long zone, parallel to the northern frontier of the kingdom, between the mountains of Erz Gebirge and the zone of the coal formation; and consequently are more distant from the Danube than some of the coal beds are. The lignite is situated principally to the left of the Elbe, in Western Bohemia. It is much more rare in Eastern Bohemia.

The finest deposits are at Kaaden, Saatz, Priesen, Komotau, Briüx, Bilin, Passalberg, Laun, Tœplitz, Aussig, left bank of the Elbe.

Important areas occur near Eger and Carlsbad. The thickness of these beds is frequently more than 6 metres = 20 feet English. It extends to 20 metres = 65 feet, to 80, and even to 100 feet thick!

It is a lignite whose vegetable substance has been completely transformed into a bituminous paste. It swells in the fire and leaves but a small quantity of ashes; fracture conchoidal. One might readily take it for perfect coal, if its colour had been of a well characterized black, instead of a deep brown. It is this colour to which it owes the name of *Braun kohle*. The abundance of this lignite is such that, in those places where it contains the largest proportion of earthy matters, it is burned in order to obtain the ashes which constitute an active manure.

As the space occupied by the formation which contains the lignite is vast, —since a single basin, that of Komotau, Briüx, and Tœplitz, is 65 kilometres = 40 English miles, long, and has a mean breadth of thirteen miles,—the resources of Northern Bohemia, in lignite, may be regarded as indefinite.

Analysis.—M. Balling has found in the lignite of Elbogen 6.66 per cent. only of ashes. He acquired by distillation, 37.18 per cent. of a species of tumid coke. All the rest passes off in gas, in tar, and in empyreumatic liquid.

Peat and Lignite.—At several places, the peat is of such purity that it admits of being carbonized or coked, and afterwards of being employed in charging the high furnaces for smelting iron. It is this which goes to the forges of Mayer Olfen, near Marienbad. This carbonized peat has been substituted with advantage for wood charcoal, in the proportion of one-third.

At Schlackenwerth, in the north-east of Bohemia, the peat receives a

similar destination. It exists also in the environs of Budweis; and still more in Bœhmer-Wald, the chain which separates Bohemia from Bavaria.*

Count Sternberg and M. W. Haidinger have published a memoir on the basaltic tuf, containing silicified wood, at Schlackenwerth. In this matrix is found a great quantity of trunks of trees, partly standing upright and partly reclining. They are filled internally with calcareous spar. Occasionally are recognized among these fragments, impressions of leaves of dicotyledonous vegetables. The circumstances under which these fossils appear, justify the conclusion of Count Sternberg, that there was in this place a forest in former times, which was enveloped by the basaltic tuf while in the soft state.

Fossil wood of the Butzenwacke of Joachimsthal.—This substance, which is locally called "*Sündfluth-Holz*" [wood of the deluge] is of the same class referred to above.

On the employment of Peat in the manufacture of Iron.

For some time past, experiments have been made to employ turf in the metallurgic arts; but its regular use only dates within a very few years, and generally, although this substance exists in great abundance in several localities, it has been hitherto disdained; because it was supposed to be incapable of developing the high temperature necessary for the making and casting of iron.

The experiments undertaken in the Landes, in Wurtemburg, in Bohemia, and Bavaria, have, in the meantime, been crowned with success; and it is permitted to believe, that the employment of peat in metallurgy is destined to extend, in proportion as the perfecting of the modes of communication and transportation will enable this fuel to be brought at a low price to the works where it is to be consumed.

The memoir of M. A. Delesse, in the Annales des Mines, Vol. II., 1842, p. 739, combines a great mass of practical details on all that relates to this subject. His observations extend both to the process of casting or smelting by means of a mixture of turf and charcoal, and to the making of iron with peat in the reverberatory furnaces.

It was known, previously, that peat had been successfully used in the puddling and refining furnaces; but, until lately, it was thought impossible to employ turf in high furnaces, for making pig metal. In several parts of Germany the "administration of mines," admitted, in principle, the possibility of making cast-iron of good quality, with a mixture of charcoal and peat, or of carbonized peat. For instance, in Bohemia and Bavaria, which possess rich turbaries, they now will only grant concessions for high furnaces, in various localities, upon the condition of employing a certain proportion of turf in the process.

Iron works of Ransko, in Bohemia, with Peat for Fuel.†

High Furnaces.—These works are situated at the south-west extremity of Bohemia, and belong to the Prince of Diétrichstein. They consist of two high furnaces and two cubilots, which are worked with a mixture of turf and charcoal. There are also several refining fires; the establishment comprising four hundred workmen.

* M. M. Chevalier, in Annales des Mines, Vol. I. 1841, p. 575. See also Vol. XVIII. p. 465.

† Report of Mr. Delesse, in Annales des Mines, abstract.

The turf is brought from the turbaries situated some leagues from Ransko. It is there dug in bricks or oblong pieces; of which the three dimensions are 35—16, and 13 centimetres [$= 13\frac{3}{4} \times 6\frac{1}{4} \times 5$ inches Eng.] These bricks are exposed in piles to the air, during the fine season, where, in drying, they contract nearly to one third; so that when they are carried to the iron works their three dimensions are there found to be about $7 \times 3.5 \times 2.4$ inches. A cube metre [$= 35\frac{1}{4}$ Eng. cube feet,] contains 590 of these bricks.

In general, these peat bricks are not employed until one year after having been dug; and it is considered good to wait even a longer time. They are stored under the sheds attached to the high furnace, and are, of course, sheltered from the rain. The fuel receives no further attention or preparation. It was at first proposed to use it in the carbonized state; but, as regards this particular quality of peat the carbon obtained was not found much more advantageous, practically, than the peat itself, and it became too expensive.

They next essayed to dry it in kilns, by means of the waste heat or flame of the high-furnace. In time this was also abandoned; because it required immense apparatus to dry all the turf required for consumption at the works; and because this operation is always dangerous, the peat catching fire with great facility; and, finally, because the advantage acquired on one side would scarcely compensate the expense of manipulation, on the other.

In France and in Wurtemburg, they have essayed, several times to compress the peat, to discharge the water, and to condense the combustible matter into the same volume; but experience has shown that this operation is costly and difficult to execute, on account of the elasticity of the peat. Besides much of the combustible substance escapes with the compressed water. On this account they employed, at Ransko, non-compressed turf, simply dried in the air.

Two varieties of peat are used here, the distinctions of which are pointed out by M. Delesse. One of these weighs 400, the other 587 lbs. English, the cube metre of $35\frac{1}{4}$ cube feet English. They cost at the iron works 1*fr.* 34 [= 13*d.* Engl. = $0.26 Amer.] per stere]= $35\frac{1}{4}$ cube feet Eng. The weight and cost per stere of the different species of charcoal, employed in the high furnaces with the peat, are as follows:

	Fr. Kil.	Eng. lbs.	Cost at the Works.			
Charcoal, resinous wood,	125 =	275 =	4*fr.* 14*c.* =	3*s.* 4*d.*	=	$0.80
Charcoal, hard wood, heavy,	213 =	468 =	5 49 =	4 5	=	1.06
Charcoal, employed,	143 =	314 =	4 40 =	3 6	=	0.84

The price of a volume of charcoal is thus more than triple that of an equal volume of peat; it will, therefore, be advantageous to exchange, as soon as possible, the charcoal for the peat.

The ore smelted here is clay-iron stone, of moderate quality, and the fuel is, generally, turf and charcoal mixed. In the making of a ton of iron are employed,—Turf, 34 cwt. 3 qrs., costing 8*s.* 9*d.*; Charcoal, 30 cwt. costing 24*s.* 7*d.*; together, £1 13*s.* 4*d.* Producing iron of the very highest character.*

At Schlakenwerth in Bohemia, near Carlsbad, is a high furnace, which works with a mixture of charcoal of wood and peat charcoal.

The peat is raised upon the plateaux of the Erzebirge, at more than 1000 metres elevation, and its exploitation is only practicable during two months

* Mining Journal of London, Dec. 20, 1845.

in the year. They carbonize it in the same manner as wood, in circular piles, and obtain a very dense charcoal, which, on an average, does not contain more than five per cent. of ashes.

The stere of peat charcoal weighs 300 kilogrammes = 660 lbs. English; and the stere of wood charcoal weighs only 141 kilogrammes = 310 lbs.; used in equal quantities in the high furnaces.

The analysis of the carbonized turf is as follows, on the authority of M. Debette :—Fixed carbon, 67; Volatile matters, 30; Ashes, 3; total, 100.

Cubilot Furnaces.—A mixture of equal parts of peat charcoal and wood charcoal is employed in the cubilot furnaces of Bohemia, with heated air. Consequently, in the cubilot, one volume of peat produces absolutely the same effect as one volume of charcoal.

See also an article "on the applicability of peat to manufacturing iron," in *L'ancre*, and on the same subject in Mining Review, June, 1840.

We have taken much pains, in the foregoing valuable practical statements, to reduce the German and French weights and measures to those of England; and also to exhibit the prices both in French, English, and American currency. The results are thus made immediately intelligible to our readers.

Iron Manufacture.

In Austria.—From recent statistical returns, it appears that all the provinces of the Austrian Monarchy, with the exception of the provinces of Venice, along the coast, and Dalmatia, are productive of iron. The establishments in 1841 were as follows :—High Furnaces, 258; Forges for Iron and Steel, 835; Fires therein, 1955; Hammers or Anvils, 1538; Puddling, re-heating ovens, and Forges, 282.

Production of cast and moulded metal in 1841, 2,720,622 centners of 123½ lbs. = 151,000 English tons.

The total produce of the iron industry is valued at 32,000,000 florins at 2*s*. 6*d*. = £3,200,000.

Styria has long been distinguished for its manufactory of scythes, which have supplied the greater part of the world. The annual make is thus stated :—Of Scythes, 3,965,000, made in 175 establishments; of Sickles, 1,159,000; Knives or Shears for cutting straw, 83,000.

Statement of the annual production of Iron in the Austrian Empire.

Pig and Cast Iron.			Wrought Iron.
Years.	Tons.	Value.	Value.
1841	151,000	Francs.	Francs.
1842	180,000		
1844		144,000,000	77,600,000
1845	190,000		

Railroads, Canals, Steamboats, &c.

Austria is by no means behind her continental neighbours in securing for her people the benefits of rapid and cheap transportation, by means of railroads, no less than sixty thousand workmen being now, or were very recently, employed in their construction.

An iron railroad, seventy-five miles in length, has been constructed from

Budweis in Bohemia, to Linz in Upper Austria, and finished in 1829; since which it has been extended on the south side of the Danube, as far as Gmunden.

Another railroad, between Prague and Pilsen in Bohemia; and another from Vienna to Bochnia, in Galicia, about 400 miles long. A railroad from Vienna to Trieste is in contemplation; another between Venice and Milan is in progress, whose length will be 300 kilometres = 186 English miles. Besides these, and an immense length of admirably finished common roads, we are informed that the Austrian Empire has 4332 miles of navigable rivers, chiefly for steam vessels, 229 miles of lakes, and 831 miles of canals. To this statement we might add the return of Austrian shipping employed along the coast; amounting in 1834 to 3231 vessels, having a tonnage of 197,923 tons, and employing 16,491 men.

A steamboat company carries on a spirited business between Trieste and Venice, the Dalmatian harbours, Greece, Smyrna, and Alexandria. The tenth steamboat of this company was launched in 1838.*

System of Railroads in the Austrian Dominions in 1846.

The Austrian system of railroads projected comprehends the following lines:

	Total Miles.	Completed and open for Commerce.
Vienna to Trieste, finished to Gratz, - -	335	148
Northern Line, - - - - - - - -	497	190
Vienna to frontier of Bavaria, - - -	194	16
Eastern Line, - - - - - - - -	311	84
Venice to Milan, - - - - - - - -	190	19
Vienna to Ternan, by Presburg, - - -	51	51
Grunden to Prague, by Lintz and Budweis, -	286	156
Budweis to Prague, - - - - - -	71	
Total,	1935	664

* McCulloch, Austrian Empire.

GERMAN STATES.

KINGDOM OF HANOVER.

Area 14,276 square miles. Considerable coal deposits occur in this kingdom, ranging between Osnabruck and Hildesheim, to the south and south-west. They give employment to more than a thousand workmen.

The official return of coals produced in the year 1838, was 2,260,000 bailles. Coal is found in many different localities on the hills that divide the Weser from the Leine; and, with greater convenience for transit, it might be made available for every want of a mining district. At present, however, only 2,260,000 cubic feet are worked yearly. The smelting houses use coke and wood.*

The policy of the government is very unfavourable to the prosperous development of the mineral resources of this country, from the absurd plan of keeping the mines in its own hands. Dr. Mantell states that the productive coal-fields of Bückeburg, in Hanover, all situated in deposits of the Wealden period.†

Peat.—Many peat moors exist in this country. Among them the largest are the Bourtanger moor, on the Ems, and the Hoch moor, in East Friesland.

At Luneburg are valuable deposits of gypsum, and springs of salt, from which 160,000 centners of salt are annually obtained; the evaporation being effected by means of turf, and is conducted under a special commission, the government having a monopoly of the article.‡

GRAND DUCHY OF OLDENBURG.

The fuel consists almost wholly of Turf, which is very abundant in the marshes.§

* Mantell, Wonders of Geology, p. 688, and "Medals of Creation," Vol. I. p. 87.
† McCulloch, Vol. I. p. 1061.
‡ Ibid. Vol. II. p. 353. Amer. Edit.
§ McCulloch, Gazetteer, Vol. II. p. 509.

HANSE TOWNS.—[HANSEATIC LEAGUE.]

REPUBLIC OF HAMBURG.

Imperial Free City.—The principal commercial city and sea-port of Germany.

By a law of the Senate and citizens of Hamburg, December 12th, 1839, coals are ordered to be imported free of duty.*

The Importation of Coals from Great Britain.

Years.	Lasts.	Tons.	
1789,		26,500	
1836,	20,034	66,720	See the Zollverein.
1837,	23,737	78,610	
1838,	30,288	100,960	
1841,		173,437	
1844,		171,865	
1845,		227,500	

Besides these coals, imported for consumption, there are others in transit, and are also exempt from duty.

The *last*, although in general use at one time for measuring grain and seeds, is not now usual in the coal trade. The last contained 99,540 cubic feet.

The last of Hamburg contains 11.2 Winchester quarters, or 88 Winchester bushels. A keel of coals yields from 8 to 9 lasts. The last of coals is 3½ tons, English, at Hamburg.

The commercial last is 6,000 lbs.=2,905 kilogrammes,=2⅞ English tons

The last of coal of Bremen is 5 tons, 672 lbs.=2 Newcastle chaldrons, =106 cwt.

The last of grain of Bremen is 80.7 Winchester bushels,=10,087 quarters.

Peat prevails in the humid valleys of the environs of Hamburg. The bottom of the marshes of the valley of the Elbe consist of turf beds, which rise to the surface in some places. They rest upon considerable deposits of rolled flints, and of sand. M. Zimmerman suggests whether these last do not cover an older coal or bituminous formation; for it often happens that the workmen meet with fragments of shale and coal.†

BREMEN.

Importation of bituminous coals from England, in 1835, 1240 tons; in 1836, 1965 tons. From Belgium, in 1840, 2855 tons.

* Pope's Journal of Trade, 1844, p. 356.
† Bulletin de la Société Geologique de France, tome X. 233.

NETHERLANDS, OR HOLLAND.

LOW COUNTRIES.—PAYS-BAS.

Coal imports.—Besides those stated to be received from the United Kingdom, coals are imported from Belgium and the Rhenish Provinces of Prussia, and can be afforded for about similar prices.

When Holland was united with Belgium, she excluded English coal, by law, 26th Aug. 1822, by a high duty of about 16*s.*, = $3.87 per ton, with a view to the protection of the Belgian collieries. Since the separation of the two countries, she has put all coal on the same footing, and the English have regained their trade.* It is only since the Belgian revolution that English coal has been admitted to entry, otherwise than upon payment of a duty which was prohibitory, viz., 11*s.* 8*d.*, = $2.82 per ton.

From 1830 to 1842 the import duty levied by the Dutch on English coals was 6*s.* 10*d.*, = $1.65 per ton.

From 1835 to 1842, although the English export duties had been generally remitted on coal to foreign countries, they had been retained as regards Holland, she being one of the two states not recognizing the reciprocity duties, 4*s.*, = $0.96.

Table of Importations of Coal into Holland.

From England.†		From Belgium.‡	From Prussia.§	Value of Coal imported into Holland.	
Years.	Tons.	Engl. tons.	Engl. tons.	Francs.	£ sterling.
1789	131,500				
1831	123,445				
1832	123,042				
1833	114,238		46,300		
1834	94,447		42,500		
1835	115,198	5,100	47,000		
1836	127,833	7,190	50,000		
1837	120,317	6,590			
1838	149,137	7,150			
1839	180,348	17,300			
1840	205,757	59,910			
1841	206,060	95,650			
1842		102,697		3,294,000	133,000
1843				3,033,000	122,580
1844	97,970				
1845	139,288	....	....	....	....

On the 5th November, 1842, the ships of Belgium and Great Britain were assimilated with the national shipping of the Low Countries, whence it followed that the entry of coal into Holland was to be considered free.

* Letter of a British merchant; Mining Journal, April, 1842.
† Parliamentary Reports of Revenue, Commerce, &c.
‡ Official Returns of the Commerce of Belgium, published in 1840 and 1841.
§ Parliamentary Records of the United Kingdom.

In Amsterdam, the price of good coal from England or from Belgium is generally about the same, viz., about 23*s.* per ton, and at Rotterdam, 25*s.* per ton. For all purposes, the quality of the one is equal to the other, and it is therefore obvious that the imposition of a duty on the English coal, by either party, would have the effect of transferring the trade with France and Holland into the hands of the Belgians.

The imposition of the duty on exported coals in England, in 1842, small as it was, had an unfavourable influence on the trade with Holland, but is now removed.

By Treasury letter, August 20th, 1843, Netherland vessels are granted the same privileges in the exportation of coal from Great Britain to ports not Netherland, as are granted to the vessels of Russia, Prussia, and Sweden.*

A large portion of the English coal exported into Holland, is for the use of the English gas works at Amsterdam, Rotterdam, and Haarlem. Two English companies have embarked a capital of £800,000 in establishing the invention of gas lighting on the continent.

After the gas works, the principal use for English coal is for private burning.

Large quantities of bituminous coal are imported into Holland from Belgium, Westphalia, and the Rhenish provinces of Prussia. All these come into direct competition with the English coals.

Prussian coals received in Amsterdam, direct by the Rhine,

1843,	1096 tons,
1844,	1065 "

In Holland, pit coal used to be sold by the *hoed.*

Nine *hoeds* are equivalent to 5 Newcastle chaldrons of 2½ tons each; rather less than the last of Bremen. One mudde or hectolitre = 2.84 bushels; 30 mudden = 1 last.

Peat.—Holland possesses no mines of mineral coal. As some reparation for this privation, nature has furnished her with inexhaustible supplies of another description of fuel, in the shape of peat; a cheap and inestimable resource to the poor, accessible at their own doors.

In a compressed state, peat approaches more closely in economical value to coal, than is usually supposed. It has been successfully employed as a substitute for the latter, both in Europe and America, in iron works. For the ordinary domestic purposes of the poor, as we have witnessed in Holland, Scotland, Wales, Ireland and England, the pungent quality of the smoke forms the chief objection to its use. This complaint obviously arises from the imperfect application of the fuel, as formerly prepared.

It has even been found that gas, for lighting, can be produced from it. As long ago as 1683, J. J. Becher published an account of his having not only produced gas in England from common coals, but, in Holland, from peat or turf.†

The Dutch have a process of converting peat into a kind of coke or charcoal, by charring it under a cover, to exclude the atmospheric air. This method, in some respects, resembles the process of making coke or charcoal by "stifling:" but for domestic daily use the Dutch employ very simple means, such as are at every one's disposal. It is first burnt, and when red hot, is taken from the fire, put in a close earthen vessel or copper pot, and covered with a wet cloth. The air being excluded, the fire is soon extinguished, and the peat, when cold, resembles charcoal, except being covered

* Pope's Journal of Trade, 1844, p. 342.

† History of Fossil Fuel, p. 405.

with white ashes. If properly charred, it burns with very little smoke, and gives a uniform and steady heat.

This fuel is constantly used in Holland during the winter, in the green-houses and the numberless summer houses in that country, for the preservation of exotic plants during the frosts.

According to Messrs. Blavier and Mické, it requires 1666 pounds of charred peat to produce the same effect as 740 pounds of charcoal.* The experiments of Mr. Tredgold, relative to the principles of warming buildings, are conclusive. He ascertained that the number of pounds of fuel requisite to convert one cubic foot of water into steam, is in the following proportions:

Of Newcastle coal,	8.40 pounds,
" " coke,	7.70 "
Of charcoal,	10.60 "
Of peat,	30.00 "
The charred peat,	23.00 "

In 1837, the "Netherlands Steam Navigation Company" announced the discovery that the long turf or peat which is so plentiful in the environs of Drenthe, has the quality of heating, in a better manner than the coal generally used, the steam boilers of vessels and manufactories. Such a fact seems at variance with the foregoing experiments.†

In Ireland, in 1837, it was announced as an interesting fact, that turf was then used as fuel on board the steamers plying between Limerick Clare and Kilrush. The Garry-owen made the passage between Kilrush and Limerick, fired with turf, in three hours and twenty minutes.

We have introduced, under their proper heads, a great many notes as to the application of peat, in Ireland, Scotland, Hanover, Denmark, the United States, &c.; and especially the recent employment of peat in all the processes of iron making in Bohemia, Bavaria, Wurtemberg, France, &c.

Railroads.—One principal line was completed in 1846, of 53 miles. The cost was little more than £5000 per mile, of double track.

Province of Dutch Limburg, ceded by Belgium to Holland in 1839. The east half, occupying the right bank or east side of the river Meuse, including the city of Maestricht and 124 communes.

In this ceded district, are several mines of coal and some of iron. There were, in 1838, 35 concessions on the right bank of the river definitively conceded, and 20 others provisionally appropriated; in all 55, having 57 mines in activity, and employing 4275 miners. These have greatly increased of late. The results of these mines are incorporated in the official returns made to the Belgian government, in 1842, to which we refer the reader.‡

* Chemistry of the Arts, Amer. edit., p. 25.
† Mining Journal, 1837, Vol. IV. p. 6.
‡ Rapport au Roi; Statistique de la Belgique, Bruxelles, 1842.

POLAND.

REPUBLIC OF CRACOW.

Area 490 square miles; population, 124,300 persons.

Coal strata extend from Hultschin to Krzesowice.

The coal measures are stated to repose upon a black marble, used in the arts, and of the age of the carboniferous limestone of England. Numerous vegetable fossils, common to the coal measures elsewhere, have been identified by M. Pusch.*

Cracow.—Independent Republic, formerly part of the kingdom of Poland.

A coal basin exists near Cracovie. This coal, in great measure, supplies the place of wood fuel, which has been much neglected by the government.

This territory contains rich mines of mineral coal. The collieries of Iaworzno furnished, in 1831, upwards of 128,660 korzecs of coal.

Coal is raised in considerable quantities at Bendzine, Reden, Niemcy, &c.†

Orovicza.—A coal basin.

The various coal basins which exist to the west of Prague, the south-west of Breslau, the north-west of Cracovie, and at Orovicza, upon the frontiers of Hungary and Transylvania, do not apppear to be accompanied by the mountain limestone.‡

Amber is found in a great many places, in the sandy districts of Poland, at a very great distance from the sea, and occurs mixed with cones of the pine tribe and lignites; indicative of its tertiary origin.§

Wood.—Most of the larger forests belong to the crown, and are felled in portions, annually, so as to be cut every fifty years. Mr. Jacob states, that the wood, cut in one year, on the crown-lands, produced £48,000 sterling.||

* Manual of Geology, De la Beche, p. 421. † McCulloch.
‡ Bulletin de la Société Géologique de France, tome XI. p. 172.
§ Ure's Dictionary of Arts, &c. || Jacob's Report on the Agriculture of Poland.

NORWAY.

Area, 121,725 Br. square miles; population in 1833, 1,150,000 persons.

Kongsberg.—Anthracite occurs in this argentiferous district, probably of no great amount. Anthracite also occurs in the numerous metalliferous masses which are inclosed in the gneiss formation of Sweden and Norway.

No bituminous coal has been found or worked in Norway; but *Berendish*, between the North Cape and Spitzbergen, appears to consist principally of the coal formation. The coal is occasionally brought home from thence by the whaling ships.

It was not until some centuries later than in Sweden, that the Norwegians commenced to draw forth the mineral riches of their soil. For a long time the Danish government, by a ridiculous policy, sought to stifle this species of industry. King Christian II. was the first sovereign who commenced to develope these resources, and sent for miners from Germany for that purpose.*

English coal is imported chiefly for the use of the copper mines of Kaafjord or Alten.—In 1829, 6,370 tons; 1830, 4,354; 1831, 3,774; 1832, 4,454; 1834, 3,573; 1835, 5,602; 1836, 7,165; 1837, 10,378; 1838, 14,630; 1839, 10,703; 1840, 19,757, and in 1841, 15,894 tons.

A keel of coals in Norway is equal to twenty-one tons, English.

Fossiliferous transition formations, which constitute in Sweden and Norway several large areas, superposed on the gneiss, contain bituminous schists. Besides these, in the southern region, is found a succession of beds which belong to the coal formations, triasic, liasic, and cretaceous.†

Iron, annual production in 1842, 107,420 quintals.

* Memoire sur les dépôts métallifères de la Swède et de la Norvége, M. Daubrée, in the Annales des Mines, tome IV. p. 210, 1843.

† Hisinger Mineralogische Geographie von Schweden.

SWEDEN.

Area, 176,715 square miles. Population, in 1839, 3,109,772 persons.

Custom-house System of Weights, Measures, and Currency.

The Swedish tonne is = 1 hectolitre, = 5565 dec. 1 English ton being 11.26 hectolitres; consequently there are 7.21 Swedish tonnes to 1 English ton.*

The skeppund or ship-pound, = 135 kilogr. 20 dec. = 298.25 English lbs.; or in other cases, 272 lbs.

7½ Skeppunds, = 1 English ton.

£1 Sterling, = 12 rix dollars banco.

1 Rix dollar banco, = *d.*20.9 English pence.

1 Rigsbankdaler, = 48 skellings, = 2 fr. 16 c. = 1*s.* 9*d.* Engl., nearly.

Anthracite.—Throughout the greater part of Scandinavia, comprising Sweden, Norway, Lapland, and part of Findland, gneiss and the schistose crystalline rocks which usually accompany it, are the most prevalent. They are remarkable for the numerous metalliferous lenticular masses or collections, which are subordinate to the gneiss. These beds enclose masses of anthracite, which have not hitherto attracted much attention. Graphite is also encountered in the non-metalliferous gneiss.

Anthracite of Dannemora.—There are sometimes found in the middle of the celebrated iron ore beds of Dannemora, morsels of a combustible which M. Hisinger has denominated anthracite, but which, on chemical examination, M. Daubrée finds to approach nearer to coal. His analysis is as follows:

Carbon per cent.,	49.20
Volatile matter,	21.80
Ashes, residuum,	29.00
	100.00

Thus, although this combustible occurs in gneiss, accompanied by matters which appear to have been submitted to a high temperature, its composition is not that of anthracite; it approaches to the true coals.

It is the opinion of M. Daubrée, that the metalliferous beds enclosed in the gneiss of Sweden, are contemporaneous with the crystallization of this formation; and, consequently, are referable to the most ancient geological epochs, of which there remains to us the distinct traces. The presence of anthracite in these masses, and the existence of carbonaceous matter in the limestone of Dannemora, seem to indicate that the entire gneiss formation of Scandinavia and Finland was deposited in the sedimentary manner,

* Documens sur le Commerce extérieur, Paris, Juin, 1843.

when vegetation already existed on the surface of the globe.* This is also the conclusion that M. Elie de Beaumont has rendered very probable, with relation to the gneiss of the Vosges, and to that of other localities.†

Scania.—Bituminous coal, probably belonging to the oolitic group, is worked at Helsingberg, at the entrance to the Baltic, in the south part of this kingdom. Similar coal mines are in operation at Höganes and at Höer, in Scania; but they cannot compete, as regards price, with the English coals, its quality being, in fact, as might be supposed, very inferior.

An account of the coal-field of Höer has been given by M. A. Brongniart. It is apparently, identical in age with the oolite coal-field of Yorkshire. M. Brongniart describes four species of plants in this formation which are analogous to the family of Cycadeæ, and are accompanied by other fossil vegetables, which differ entirely from those of the regular and more ancient coal strata.‡ Sweden possesses several mines of this inferior coal, but to a limited extent, she receives her supplies from England of the better kind of coal. The coal mines of Sweden, previously to the removal of the English export duty, furnished more than double the imported quantity.§ On the whole, the secondary formations of Sweden are remarkably deficient in both of those valuable productions, coal and salt.

On the 19th of October, 1843, the Swedish government entirely abolished the duty on the importation of British coal, which duty was previously four shillings per ton. So far as Sweden is concerned, therefore, it would seem that the elevation of the British duty, in the remodelled tariff of 1842, answered the purpose, as regards England by raising the revenue, at the expense of the foreign consumer. But this English export duty was removed in 1845. The importation appears to be a matter of necessity on the part of the Swedish government. That country is deficient in coal; while the forests have been greatly thinned and impoverished by the exclusive consumption of wood, during some centuries, in the smelting of iron, as well as in the shape of fuel for domestic purposes; without any precautions having been taken for a renewal of the supply of timber, or for the re-planting and protecting the old forests. A large proportion of the fire-wood required for the consumption of Stockholm is now brought from Finland.

Statement of Coal imported into Sweden from Great Britain.||—In 1831, 6,150 tons; in 1832, 7,702; in 1833, 8,504; in 1834, 11,658; in 1835, 16,076; in 1836, 15,689; in 1837, 13,035; in 1838, 23,692; in 1839, 24,719; in 1840, 21,532; and in 1841, 26,941 tons.

In the French Commercial Statistics, Sweden and Norway are always united in one return.

Bitumen, has been met with in many of the Swedish mines. First, in all the localities of graphite and anthracite; and, second, in some others, as at Gräsberg; in the parish of Grangjärde; at Bëspberg; near Norberg, &c.

From this association, it appears very probable that the bitumen and the coal masses result from a distillation of combustible minerals.

The bitumen is commonly found in drops, superficially, or enclosed in small spheroidal cavities, in the centre of quartz or carbonate of lime; from

* Memoir on Sweden and Norway, by M. Daubrée, p. 199.
† Explication de la Carte géologique de France. Tome I. p. 514.
‡ Annales des Sciences Naturelles, Vol. IV. p. 200. Also, Transactions of the Geological Society of London, Vol. II. p. 400.
§ Observations on the proposed duties on the exportation of Coal from Great Britain, 1842.
|| Parliamentary Records.

whence it is evident that it must have existed before the crystallization of these two substances.

Amber is found in some situations along the sea coast.

Iron is only permitted to be smelted and manufactured in Sweden under the sanction of licenses granted by the College of Mines. The quantities of iron licensed to be made, vary from fifty to five hundred tons, annually. Some bar-iron works have licenses for 1000 tons; but no iron-master is permitted to send more iron to market than his license authorizes. Care is taken not to grant the license to any one unless he have the command of forests equal to the required supply of charcoal.

The erection of new forges depends, first, upon having a supply of charcoal, without encroaching on the forests which supply your neighbours; and secondly, on the quantity of pig iron which the college knows to be disposable.

The courts of the mines decide all disputes that arise among the iron-masters, regarding the exceeding of their licenses, encroachments, &c. It is needless to dwell on the impolicy of such regulations.*

Certain changes, however, appear to have been recently made in the iron manufacture. The iron-masters have hitherto used only charcoal in the smelting of their metal; but they have now adopted the Lancashire method, and produce iron of the very best quality.†

In 1803, there were 338 furnaces and 426 forges, which produced 363,315 ship-pounds, = 48,000 tons; in 1812, 451,137 ship-pounds = 60,000 tons; in 1835, 70,000 tons;‡ in 1839, 448,000 ship-pounds, = 90,000 tons;§ in 1844, 100,000, and in 1846, 145,000 tons.

Exportation of Iron from Sweden.—In 1830, 53,446 tons; in 1835, 70,463; in 1838, 81,754, and in 1845, 109,881 tons.

The United States take the largest quantity; Great Britain imports the second; France the third; Germany the fourth, in rank. The recent increased exportation is attributable to the extraordinary demand for railroad iron.

* McCulloch, Art. Sweden.
† Mining Journal, Oct. 1845.
‡ History of the Iron Trade, Scrivener.
§ McCulloch.

DENMARK.

Area of the kingdom, 21,856 square miles. Population in 1834, 2,033,-265 persons.

English Coal imported into the Baltic, generally.

In 1834, 111,204 tons; 1839, 248,369 tons; 1840, 231,752 tons; 1841, 310,271 tons.

In 1847, there were exported from England into the Baltic 1241 cargoes of coal, as follows:—From Newcastle, 576; Sunderland, 179; Stockton, 94; Hartlepool, 134; other ports, 258; total, 1241.

Denmark is supplied largely with coal from England.

*Quantity of Coal imported from Great Britain into Denmark.**

In 1789, 26,500 tons; in 1828, 61,392 tons; in 1831, 62,213 tons; in 1832, 62,786 tons; in 1833, 74,745 tons; in 1834, 72,186 tons; in 1835, 83,409 tons; in 1836, 86,281 tons; in 1837, 92,275 tons; in 1838, 105,-109 tons; in 1839, 129,005 tons; in 1840, 126,779 tons; in 1841, 151,146 tons; in 1844, 140,608 tons; in 1845, 168,158 tons.

Peat.—The want of coal is partly compensated by the abundance of turf in various parts of this kingdom.

In the peat beds, "tourbieres," of Denmark, which appear to be derived from ancient forests of fir, there are found, in the clefts of the wood, a crystalline matter, which at first was supposed to be the scheererite, as found in the brown coal of St. Gallen in Switzerland. We know not the name of this new substance, further than M. Forchammer designates it as a hydrated essence of Térébenthine, and adds that it is found abundantly in other peat bogs, particularly in Holland.†

Railroads.—Sixty-six miles completed in 1846, costing £520,000, or about £7,880 per mile.

ISLAND OF BORNHOLM—[Belonging to Denmark.]

Large quantities of coal exist in this island. Geologists have not united in determining the age of this formation: whether it be of the true carboniferous period, or a lignite like the Bovey or brown coal of a later date.

According to Dr. Beck of Copenhagen, an eminent Danish naturalist, the formation of the Bornholm coal deposits corresponds, in mineral character and in fossil plants, with the Wealden group in England. The vegetable

* Parliamentary Records. Pope's Journal of Trade, 1844, p. 342.
† Annales des Mines, tom. II. 1842, p. 413.

remains are evidently similar to those found in the Hastings sands; although in this case the shells are marine.*

We are further informed that, hitherto, the Bornholm coal has not been profitably worked. This formation, Dr. Fitton conceives, in confirmation of Dr. Beck's opinion, may correspond with some part of the Wealden series; many of the fossil plants being the same.†

There are also many lignites of large size, embedded in peat, in the island.

FÉROË OR FAROË ISLANDS—[Belonging to Denmark.]

The geology and mineralogy of these islands have been investigated and ably detailed in a memoir by M. T. Durocher. These rocks consist of the primitive class, intermixed with trap, porphyry, euphotides, diallage, &c. The geological phenomena chiefly exhibited here consist of an immense and very powerful formation of trappean rocks, isolated in the middle of the ocean. Peat and coal are abundant on some of these islands. It is said that the government of Denmark has determined on having the coal-pits in the Faroe islands worked by convicts. The coal-field of Suderoe is six miles in length by two in width. The cost of transportation has, hitherto, prevented the mines from being worked.‡

SUDEROË ISLAND.

This island is remarkable for the beds of lignite which occur in a sedimentary deposit amidst argillaceous strata, and appear to be in sufficient abundance to be worked. This combustible possesses a very brilliant aspect; a fracture conchoidal, of a fine jet-black colour; but it is not homogeneous, being intermixed with black schistose parts.

Nevertheless, judging by the external appearance alone, it would be taken for a good coal, and might readily be supposed to possess much value, if the chemical analysis did not at once contradict that impression.

It burns with difficulty, and leaves much ashes; and the results of the examination show that this combustible belongs to the class of lignites, being represented by the following composition:—Carbon, 24.50; Volatile matters, 37.50; Ashes, 38.00; total, 100.§

In a subsequent memoir to that from which we have made the foregoing extract, M. Durocher furnishes some further details. The position of the lignite deposit is on the northern side of the island, near Hvalböe. Here are two beds of bituminous coal, [pech-kohl,] separated by a bed of clay. Carbonate of iron, in rognons, accompany this slaty clay, and the traces of calamites. According to the report of M. Henckell, these lignite beds extend over a length of 12,000 feet, and a breadth of 4000 feet.

ISLE OF MYGGENÄS.

Here is an analogous bed of lignite, but less extensive.‖

* Proceedings of Geological Society of London, 1835, Vol. II. p. 217.

† Dr. Fitton on the strata below the chalk, P. 330. ‡ Mining Journal, Jan. 1, 1848.

§ Annales des Mines, tom. XIX. p. 547. Recherches sur les roches et les minéraux des Isles Féroë, 1844.

‖ Notice Géologique sur les Isles Féroë. Annales des Mines, 1844, tom. VI. p. 457.

RUSSIAN EMPIRE.

Area of the Russian Empire, including Poland, 2,041,809 square miles. Population in 1838, 59,673,260 persons; exclusive of the army and navy, and the inhabitants of the mountains between the Black Sea and the Caspian, and some wandering tribes of Circassians and others.

The entire area of the Russian Empire, the largest in the world, measures 7,725,000 square miles, or one-seventh of the land on the globe.

Weights, Measures, and Money.

1 Pood, Pud or Poud = 36 lbs. 11 drachms English. Sometimes 40 Russian pounds to 1 pood.

110 lbs. Russia is equivalent to 100 lbs. English.

43 Russian lbs. = 1 poud or pood = 16 kilog. 38 = 36 lbs. 1 oz. 11 dr.

56 Pouds = 1 ton Eng. There is also another of 63 poods to the ton; and another of 50 poods to the ton.

The Russian pound is rather heavier than the avoirdupois pound.

1 Chetivert = 12,800 Eng. cubic inches = 5.952 imperial Eng. bushels = 209.740 Fr. litres.

1 Last = 13.8 Quarters.

The Moscow foot = 13.17 Eng. inches = 3.343 Fr. decimetres.

1 Russian Archine, or Arsheen, or Ell = 28 Eng. inches.

1 Russian Verst = 1500 archines = 3500 Eng. feet = 1167 yards = 1,066 Fr. kilom. Therefore a verst is two-thirds of an English mile = 5 furlongs 76 yards = 53½ chains.

150,814 Russian versts = 100 Eng. miles.

Produce of the Gold Mines of Russia, [Ouraland Siberia,] from 1830 to to 1842, belonging to the Crown and to individuals:

	Russian Pouds.		Eng. lbs.		Tons. lbs.
Mines belonging to the Crown, 1830 to 1842,	2,052	=	73,872	=	32 00
" " to individuals,	4,119	=	148,284	=	66 444
	6,171	=	222,156	=	98,444

Money.

Gold Currency.—Ducat of 1796,	$2.29c. U. S.		not in circulation.
Gold Ruble of 1799,	0.73.1 "		
Imperial of 1801,	7.83.6 "		
Demi Imperial,	3.86.6 "		in circulation.

Platina Coins.—£1 sterling.

1 Silver Copec = 0fr. 4c. = $\frac{1}{100}$ part of a silver rouble = 3*s.* 2*d.*

1 Silver Rouble = 4 Fr. francs = $0.77 United States.

Consequently 1 silver copec = 77c. U. S.

100 Copecs = 1 rouble. But the silver rouble varies in value from 3*s.* 2*d.* to nearly 4*s.* English, according to the distance from the capital, = $0.75 to $1.00.

1 Paper Rouble is worth about 10*d.* and is usually considered equivalent to 1fr. = 19.33*c.* U. S., and is also in mercantile transactions divided into 100 copecs, [represented in copper coin.]

1 Copper Copec is therefore = 1 centime of a franc = *c.*0.193 U. S.

Par value for £1 sterling in London, 6 roubles, 40 cop. of St. Petersburg, at 3*s.* 1½*d.* per each rouble.

COAL STATISTICS.

The small coal for the sugar refinery business in Russia, heretofore has been almost exclusively supplied from England: it being the cheapest fuel that the manufacturers can obtain. It was stated before a committee of Parliament, in 1829, that this branch of manufacture in Russia, was mainly dependent on the supply of English coal of the above description.*

The quantity of English coal is annually increasing for the use of gas and sugar works.

Statement of the Annual Importation of Coal from Great Britain into Russia.

Years.	Tons.	Years.	Tons.	Years.	Tons.
1810	2,316	1834	35,214	1839	78,054
1817	6,426	1835	42,061	1840	93,370
1831	31,379	1836	58,500	1841	77,152
1832	29,552	1837	58,738	1844	94,144
1833	42,736	1838	68,051	1845	150,422

No duties, whatever, are levied in the ports of Russia, upon coals imported from Great Britain. Indeed, so necessary is it considered to give, or rather to acquire, every facility for the importation of that article, that it is allowed to be landed any where, without previous inspection at the custom-house: a form to which all other articles, exempted from duty, are subjected.†

Russia is one of the few countries in Europe that imports coal for manufacturing purposes. Petersburg is lighted with gas produced from English coal, and the sugar refineries use it generally.

The coal trade with England, so far as it extends, is a very profitable one to the latter.

The commercial legislation of Russia, in 1844, imposed no restrictions on the importation of foreign coal,‡ and in 1845, England repealed her tariff duty on the exportation of coal to foreign nations.

INDUSTRIAL ESTABLISHMENTS OF THE RUSSIAN EMPIRE.

A statistical work published in Russia, under the patronage of the minister of the interior of that country, contains an enumeration, by governments and districts, of the principal works and industrial establishments of

* Mr. Buddle's Evidence, in 1829. † History of Fossil Fuel, 451.

‡ Documens sur le commerce exterieur, Octobre, 1844.

every kind existing in the empire, in 1842; with a statement of their annual products. From this work it appears that there were coal mines and quarries [number not given]—producing annually 15 millions of francs, £625,000 sterling.

Subsequently, by a note inserted in the Russian Journals there have been recently discovered [July 1844] in the neighbourhood of Moscow, in the centre of the empire, some coal beds of an immense extent, whose richness will be of a nature shortly to produce a great influence upon the industrial and manufacturing interests of Russia, Moscow, Kalouga, &c., which are the principal centres of the fabrication of the tissues of cotton, wool and silk. At Tula are found vast forges, both imperial and of private enterprise; cannon foundries, &c., which make this locality the Birmingham, and the Sheffield of Russia.*

Iron.—An estimate in the Russian State Gazette places the production of Iron in 1842, 380,000 tons. A subsequent calculation assigns for the whole quantity, 320,000 tons.

Russian System of Railroads projected in 1846–7.

They consist of four principal lines, which amount to 1600 English miles. These works are urged forward with extraordinary rapidity. In addition to the number of peasants and workmen, on the railway from St. Petersburg to Moscow, 50,000 soldiers were employed on that work, in 1847.

SOUTHERN RUSSIA.

Bessarabia or Eastern Moldavia, the most south-western Province of Russia in Europe.

Lignite.—Upon one of the gulfs of the Danube, named Yalpong, in the lower part of Bessarabia, 50 versts from Ismail, and opposite the town of [Bender ?] a great deposit of lignite was discovered by M. Lichfeldt. This fossil wood may become of great importance in that part of Russia, now entirely deprived of forests. It occurs in a tertiary formation: lying horizontally between coarse sand and calcareous clay. This lignite exists in the form of fossile masses of a greyish colour, but passing in the lower portions, into a deep black. In the upper parts are found quantities of the debris of wood, covered with bark; the pieces pressed upon one another, and intermixed with the husks of grain. This wood is thought to be that of the lime tree. It lies nearly horizontal, as before stated, its roof being formed of the calcareous clay, which is filled with many fossil shells. In the floor is a thin seam of resinous clay, also containing shells.†

Kherson Province, on the Northern shore of the Black Sea.

Bituminous coal [brown ?] has been found in abundance, through the medium of Count Woronzou, by M. Hommaire de Hell, a French engineer.

Crimea.—A peninsula of Southern Russia and in the government of Taurida; wood coal, in continuation of the tertiary range on the north flank of the Caucasus on the one side, and of the wood coal deposits of Kherson and Bessarabia on the other, is very abundant here.

* Documens sur le commerce exterieur—Paris—Dec. 1844. † Gornoi Journal, No. X.

Peninsula of Taman: on the south-east shore of the sea of Azof.
Liquid Bitumen, described by M. Verneuil.*

GOVERNMENT OF EKATERINOSLAF IN THE UKRAIN.

Donetz Coal Field, at Bakhmout on the river Donetz.—Coal is worked near the borders of the Donetz.† These coals are raised by the imperial government, but only at two spots. The pits were first opened in the last century, by English miners, employed by the Russian government.

Including small and profitless seams, twelve beds of coal occur to the east north-east of Bakhmout; seven of which are now worked. The greater part of the coal is of fair quality, and some is very good, and chiefly bituminous; all the best seams being subordinate to the mountain limestone.

The richest coal-field in this region, is on the shores of the sea of Azoff, between the Dnieper and the Donetz rivers, and a great part of it is crown property. In many places the coal crops out on the surface. M. Hommaire was offered the direction of the works at this place. He estimates that the coal, which is said to be fully equal to the best English, may be delivered at a port on the Dnieper or the Don rivers, at from 50 to 60 centimes the 100 kilogrammes, or from four to five shillings English per ton. It is believed that the Russian government will allow this coal to be exported.

Near Bakhmout the whole carbonaceous region is overlapped partially by red sandstone with gypsum, but more generally by cretaceous and tertiary rocks.‡ A section of the works at Lissitchia, and at Balkia, on the Donetz, shows that in a depth of nine hundred feet, there are twelve seams of coal, the united thickness of which amounts to thirty feet.§

M. le Baron Meyendorf communicated to the Geological Society of France, 2d April, 1838, an account of this coal-field from the investigations of himself and M. Verneuil.

This coal formation occupies a great zone, which extends from north-west to south-east. The portion which was examined by these geologists, was more than sixty leagues in length, by a mean breadth of from twenty to thirty leagues,—say 8000 square miles.

Like that of Belgium, this Russian coal-field is immediately succeeded and partially overlapped, by the chalk formation, except in certain points where the Lias formation is exhibited.

In the basin of Donetz, in 1838, were six coal works in operation, seven others had been opened in the government of Ekaterinoslaw, and nine in the country of the Don Cossacks.

The coal, in general pyritous, has only been found in a certain number of points, of sufficient purity to be employed in the arts. The formation has been greatly disturbed by revolutions subsequent to its deposit. Nevertheless there occurs, near Kamenskoy, a horizontal coal seam of 4¾ feet in thickness.‖

Mr. Murchison, in 1842, communicated the result of his observations on the coal region between the Dnieper and the Don; including, we presume, that of Bakhmout above noticed. The whole area is denominated the Donetz coal-field. It is said that this formation extends one hundred and

* Bulletin de la Societe Geologique de France—Avril, 1838.
† Trans. Geol. Soc. of London, 1822.
‡ Mining Journal, 1842, p. 131.
§ Annual Address to the Geol. Soc. London, 1846.
‖ Bulletin de la Société Géologique de France, 1838, p. 237.

fifty versts, equal to 100 English miles in length. The coal is from a few inches to seven feet in thickness. It has been asserted, heretofore, that the beds were bituminous among the sandstones and shales, and anthracitous where the rocks were supposed to be transition or grauwacke [metamorphic ?]

Mr. Murchison, however, explains that in the mineral composition of this carboniferous tract there is a striking analogy to the condition of the great British coal-field of South Wales; for one end of the tract contains anthracite, and the other bituminous coal, though the strata are, it is believed, of the same age. In the Russian case, the anthracitic masses occupy the eastern end of a tract, the major axis of which bends from west north-west to east south-east, and the bituminous coal is on the west. We may further name a parallel to this in the Schuylkill coal-field of Pennsylvania.

The Donetz coal-field is often highly dislocated, being every where thrown into broad and rapid undulations; and the coal seams have various inclinations from 20° to 70°.

In the upper part of this coal region, Messrs. Murchison and Verneuil and Count Keyserling detected a band of carboniferous limestone, which is made up of myriads of *Fusulinæ*,—fossil bodies resembling grains of wheat.

In that extensive region in the south of Russia, usually known as the country of the Donetz, Mr. Murchison, (1843) refers to one district which contains many good seams of coal, both bituminous and anthracite. M. Le Play, an eminent French engineer, selected by the Russian government, has recently described this country, and has shown the prevalence of a large amount of coal and anthracite. Another contributor has enriched the splendid work of M. A. Demidoff, with a set of tables, in which are exhibited the chemical analysis of the coals from forty-three different places, in the same country.

Mr. Murchison and his associate observers are entirely of opinion that this coal series is subordinate to the carboniferous or mountain limestone, and consequently, is older than the great English and the other western European coal-fields.

Mr. Murchison, states further, that in one section of the Donetz coal-field, at least twelve beds of *marine* limestone alternate in one vertical section, with thirteen seams of coal. In this respect it resembles the alternation of marine deposits with coal and its associated sandstone and shale, in the mountain limestone, or lower coal series, of the north of England. In the south of England, as in the north of Russia, no coal occurs in the lower or calcareous division of the system; but in Yorkshire, Durham, and Northumberland, sandstone and shales are interpolated, and the mountain limestone is expanded, as on the Donetz, into a great complex series, including seams of coal.* The eight intercalated limestone beds have a united thickness of fifty feet; three of these beds rest directly upon the coal.

M. Voskressensky, of the Imperial University of St. Petersburg, has analyzed the different sorts of coal, found in the south of Russia. The result of his experiments shows, that the best Russian anthracite which is to be found in the territory of the Cossacks of the Don, contains 94.234 per cent. of carbon; and the most inferior, that of Tiflis, contains 63.649

* Anniversary Address to the Geol Soc., 17th February, 1843.

per cent. of carbon. According to these views, the coal of Grouschevskaia surpasses in quality the best English and French coals; the former containing only 84.846, and the latter 91.98 per cent. of carbon.

By way of comparison, it may be stated, that the best American anthracite, as regards the amount of carbon, in our table, is 94.100 per cent.; and the best Welsh anthracite ranges from 90.0 to 95.7 per cent. of carbon. So that, in fact, anthracite of equal purity to that of the Donetz does exist in those other countries.

NORTHERN AND CENTRAL RUSSIA.

Messrs. Murchison and Verneuil report that, in these regions, the lower or calcareous part only of the carboniferous system exists. The inferior beds consist of incoherent sandstones and bituminous shale, which sometimes contain thin beds of impure pyritous coal, and impressions of several plants well-known in the coal measures of Great Britain.

We know very little of the carboniferous system of Northern Russia, except through these gentlemen. The coal here is stated to *underlie* the mountain limestone, and to be in a broken or disturbed condition. The authors conceive, that these carboniferous strata are of the same geological age as those of the great productive coal-field of Berwickshire, which equally underlie the mountain limestone. The coal has the lignite or impure character of the beds of coal in the Waldai Hills.

"Although rocks of the carboniferous age cover a great extent of country in European Russia, we learn from the investigation of Sir R. Murchison and his associates, that there are few places, except in the coal-field of the Donetz in the south, where the coal seams are more than a few inches in thickness, and when they are thicker, they are so poor in quality as to be rarely worth working.

The great coal-fields of England, France, Belgium and America, have no well marked equivalents there; nearly the whole of the coal-beds in the empire being, like those of Ireland, and the coal-field on the banks of the Tweed, included in the lower members of the system."*

Near Toula, in Central Russia, to the south of Moscow, good coal is worked. M. Strangeways states, however, that the quantity is so small, and the difficulty of working it, beneath a loose and half liquid bed of quicksand, is so great, that it seems unlikely to prove of much utility as a coal-field.

Some late information (April, 1844,) announces that in the immediate vicinity of Moscow, and in the central part of the empire, there have been discovered some very extensive coal formations, which, it is urged, may exercise an important influence upon the manufacturing and industrial interests of Russia.†

EASTERN RUSSIA IN EUROPE.

Carboniferous beds near Perm and the western flanks of the Oural mountains.—In 1842, Mr. Murchison described this formation, to the east of the river Volga. He considered it to be of the age of the *Zechstein* of Germany, and of the magnesian limestone of England. The coal vegetation of this age, was, he observes, peculiar. It is sometimes accompanied by thin courses of coal and lignite. But these fossil stems and leaves are also here very general indications of the presence of *copper ore*, which in the

* Anniversary Address of the Pres. Geol. Soc. London, February, 1846.
† Mining Journal, April 27, 1844.

form of grey oxide and green carbonate, is often copiously disseminated through the vegetable matters, or are arranged around the thicker branches, in masses, from which it extends, in fine filaments, into the adjacent sands or marls.

This region, therefore, is remarkably distinguished from the Donetz district, in Southern Russia, inasmuch as the coal is more recent than the English carboniferous group, whereas that of Donetz is decidedly older than the latter group.*

Wood is chiefly employed as the fuel for making the iron, in the province of Perm; and, it has been asserted that between three and four hundred thousand tons of charcoal are annually consumed here, in the process of smelting and working iron and copper.†

Mr. Murchison, on examining the fossil plants of the carboniferous region of Perm, states his conviction, in common with other naturalists, that they are all of intermediate character between those of the carboniferous and triasic eras, and that the epoch of the Zechstein was characterized by a flora peculiar to it. The author infers that the Oural mountains constituted the dry land, on which those plants grew, which were subsequently washed down into the Permian deposits, and there became the nuclei of the copper ores which are arranged around them. The thin layers of *kupfer-schiefer* of Germany may be considered as the miniature representative of this great metalliferous deposit.‡

It is to be remarked, also, that beds of vegetable stems, encrusted with rich grey sulphuret and green carbonate of copper, occur in the United States, especially in Pennsylvania, near the base of the old red sandstone, or Devonian group, and in the upper red shales of the Chemung series. We have never known the vegetables to occur without the copper, or the copper without the vegetables, in this geological position.

Oural or Ural Mountains.—Coal occurs on the west side of the range, in about north latitude 59°, on the Ousva river, nine versts from Alexandrousk. It is accompanied by rich argillaceous ironstone, which is manufactured at the latter place. Springs of naphtha, here frequently considered a sign of the vicinity of coal, abound in this region.§

Lignites, with amber, occur on the eastern side of these mountains; and, according to Mr. Humboldt, are of more ancient date than the auriferous deposits, mingled with the bones of fossil elephants in the same region.

Gold.—Although somewhat out of place here, we will state, that, in 1846, there were received at the mint from Siberia and the Ural, no less than 1,722 poods, 29 lbs.; the value of which was £4,000,000 sterling: whereas in 1829, only 315 poods were collected, of the precious metal.

In the year 1845, the total production of gold and silver in Russia, was of the value of 750,000,000 francs,=£30,300,000 sterling.

Of silver,	407,000,000 "	=£16,438,000 "
	1157,000,000	46,738,000=$226,210,000 U. S.

NORTHERN AND CENTRAL PARTS OF RUSSIA, TOWARDS THE WHITE SEA.

Carboniferous System.—Observed by Murchison and others 1840, and described in 1842. So far as has been at present discovered, he states that

* Murchison's Address, 1843. † Scrivenor's History of the Iron Trade, note, p. 52.
‡ Proceedings of the Geological Society of London, Vol. III. p. 751.
§ Transactions of Geological Society of London, 1822.

the seams of bituminous coal are extremely thin, impure, and pyritous. Beds of coal occur in the Waldai hills, to the north-east of St. Petersburg. Deposits of this age appear from thence, southward, as far as Kaluga, below Moscow. They were examined by Murchison, who reported that the coal had the same lignite or impure character as that of the Waldai hills. This coal is considered to be of the same geological age as that of the great productive coal-field of Berwickshire, which equally underlies the mountain limestone. The region we are describing is designated as the "Moscow basin."

GOVERNMENT OF ARCHANGEL—BORDERS OF THE WHITE SEA.

Peat and Lignite.—To the west of Archangel, or Arkhangelesk, in following one of the mouths of the Dwina, called Nikolski, or from Siouzemskaid as far as the monastery of St. Nicholas, the left bank of the river exhibits a bed of peat, seven or eight feet thick, which appears to be very ancient. This bed contains, towards its centre, a great number of stumps and trunks of trees; some of which are still standing or rooted, but broken off within three or four feet of the root, apparently the effect of the breaking up of the ice of the Dwina, which in times of old has cut off a great area of wood. This peat rests upon an argillaceous sand, on which the trees in question grew. It contains much iron pyrites, which, by its decomposition, renders ferruginous the waters of nearly all the rivers of the country; even the Dwina, notwithstanding its great size.*

Brown Coal.—In the district of Yarensk, near the mouth of the Vim, about north latitude 62°, and 700 versts from the town of Vologda, occurs a black bituminous slate, called by the Russians, Domanite, which resembles the Kimmeridge coal of England.

Peat.—Following the whole southern shore of the White Sea, and the northern part of the government of Archangel, even to the foot of the Ural mountains, peat occurs along the borders of the rivers, in marshy positions. We do not know to what extent this substance is applied for the purposes of domestic fuel; but we may be permitted to add here, that these turbaries have long been remarkable for the quantity of bones of mammoths and rhinoceroses which they contain. According to M. Eugene Robert, the greater part of the tusks of elephants, are buried vertically, or more or less obliquely, but never horizontally, in the peat or marl. They are sometimes seen projecting, by the smaller end, out of the ground. They are accompanied by large trunks of trees, having still all their branches. These bones become more and more abundant, as we approach the Ural: and are most numerous in the river Carra or Kara, which empties into the sea of that name, and separates Russia in Europe from Russia in Asia.

Sometimes are found on the borders of the Brida, and the Wytchegda rivers, femurs of mammoths, sunk vertically, and are then easily mistaken for old stumps of trees; their projecting extremities being broken and stained dark. The Samoides find them frequently in the pasturages of their reindeer; almost always impregnated with water, and also near the shore of rivers, whose currents often disengage them from their imbedded sites.

* Bulletin de la Societé Géologique de France, tome XI. p. 318.

POLAR SEAS.

NOVA-ZEMBLA, IN THE ARCTIC OCEAN, BELONGING TO RUSSIA.

According to a report of the Baron de Meyendorf, and M. Baer, coal has been discovered in this island. The perfect horizontality of all the coal seams, is a very remarkable and rare circumstance in the sedimentary deposits of this epoch.*

Cherie Island, north latitude 74° 30′, longitude 20° east, consists of limestone with fossil shells, sandstone, and probably secondary trap. The sandstone contains a horizontal bed of coal, from two four feet thick, and apparently others exist there.

SPITZBERGEN.

In the year 1826, some sea-horse fishers, from Finmark, brought sixty tons of coal from Ice Sound, on the west coast in north latitude seventy-eight degrees, to Hammerfest in Norway. We are informed by Captain Scoresby, that the coal is so easily procured, that many of the Dutch fishers, a few years ago, were in the habit of laying in a stock of this useful mineral for fuel on their passage homeward.

The coal of Spitzbergen, which extends beyond north latitude seventy-nine degrees, resembles, in some places, the cannel coal: in others it is brown coal or lignite, probably of tertiary date. The primitive rocks near South Cape, also at Stansforeland, and at the Thousand Isles, were observed to be covered, at a hundred feet elevation above the sea, with an interesting deposit of shell clay, apparently of the tertiary period. A formation, probably of new red sandstone, occurs in the vicinity of primitive rocks on the north coast.†

This red sandstone and the coal frequently accompanying it, seem to resemble that which occurs in Greenland and west Baffin's Bay, in the North Georgia Islands, in King William's land, Mellville Island, Point Turnagain, Bathurst's Inlet and Coppermine River, extending to Great Bear Lake.

ICELAND, BELONGING TO DENMARK.

Wood coal, or the variety called Surturbrand, has long been known here. It is black, heavy, and slightly carbonized, burning with flame. This lignite is superficial, and is found in the form of boards, as if produced from the trunks of trees, flattened by great pressure. The surturbrand of Bardestrand is found on a hill of moderate elevation, and beneath strata of sand and clay, alternating with peat. At Arnafiord it is accompanied by shale, containing bones, &c.‡

* Bulletin de la Societé Géologique de France, April, 1838, p. 201 and 240; and Bulletin of the Academy of Science of St. Petersburg.

† Professor Jameson on the geological structure of the Arctic regions.

‡ McCulloch on the lignites, Journal of Science and the Arts, 1826.

M. Link of Berlin states, as the result of his microscopic examination of Surturbrand, that the wood belonged to the dicotyledons, but not to the conifera.*

Also fossil wood in Tufa, in the mountain Drapühlid; but does not occur in sufficient quantity to be worked to profit.†

The lignite of Iceland has been pronounced by M. Duracher to be exactly similar in its quality, and in geological position to that of the Feroë Islands, and they appear to have been produced at the same epoch.‡

Another kind of mineral wood, heavier than coal, also occurs, which burns without flame, and contains calcedony, in its transverse fissures.

Turf and peat repose in beds on the granite rocks of this island.

M. Eugène Robert, in a memoir on the Geysers of Iceland, adverts to the silicified wood in their vicinity. "It is evident," he remarks, "that there has been here, in former times, a little wood of birch, which the accumulation of silica caused to perish; and there are now found a great quantity of petrified stems, which are perfectly recognizable."

The most part are entirely converted into a calcedonous quartz resembling a group of our trees passed into the state of silex, such as the wood of agatized palms."§ They are partly free from the surface of the soil, and partly are attached to the rock, which bears also a multitude of impressions of leaves of birch, that can be readily referred to the species *betula, alba* and *nana*, growing still on the island. With these are seen casts of leaves of *arbutus uva ursi*, a plant common to all parts of the island. This association ought not to occasion surprise, when it is known that this last plant is developed in Iceland upon steep declivities, and is constantly impregnated with water; as is also the peat in the Turbariès of the Island, under similar circumstances. In this locality M. Robert found hyalite or opal, incrusting the rock, while the interior of the stems of birch passed into the state of agate.

* Annales des Mines, 1841, Vol. XIX. p. 568. † Mackenzie's Iceland.
‡ Annales des Mines, 1841, Vol. XIX., p. 568.
§ Bulletin de Société Géologique de France, tome XI., p. 350.

AFRICA.

COMPRISING

1. TROPICAL AFRICA.—Kingdom of Shoa.
2. NORTHERN AFRICA.—Algeria—Morocco—Egypt—Mokattan.
3. EASTERN AFRICA.—Island of Madagascar—Mozambique.
4. SOUTHERN AFRICA.—Cape of Good Hope—Port Natal—Cape de Verd Islands—Kerguelen's Land.

AFRICA.

Egypt Government Regulations, according to Dr. Bowring's Report.

400 Drams make 1 oke, = $2\frac{1}{8}$ lbs. English. 36 Okes make 1 cantard. 100 Rottoli. 883 Okes make 1 ton of coal. 217 Okes, 1 canlar of coal. 180 Syrian okes, 1 cantard, of coal. 40 Okes, = 1 cwt. 800 Syrian okes, 1 ton.

American dollar, 19 piastres. English sovereign, $97\frac{3}{4}$ piastres. 1 Piastre is 2*d*. English, or 5 cents American. 40 Paras, = 1 piastre, = 100 piastres = £1.

It has been usual to assume or suppose that no formation or deposit of coal exists on this continent; and it is equally customary to take for granted that the assertion is well-founded. How far this assumption of the non-existence of coal in Africa is sustained by actual facts, will appear even from the scanty notes we have acquired.

Had equal facilities existed, for mineralogical and geological researches on the continent of Africa, as in other parts of the globe, there is great probability it would have been demonstrated, long ago, that it possessed a larger store of mineral wealth than has generally been assigned to it.

TROPICAL AFRICA.

Major Harris states that no quarter of the globe abounds to a greater extent, in vegetable and mineral productions, than tropical Africa; and in the populous, fertile and salubrious portions, which lie immediately north of the equator, the very highest capabilities are presented for the employment of capital, and the development of industry. Coal has already been found, though at too great a distance inland to render it of any service without water communication; but this combustible, doubtless, exists in positions sufficiently favourable for the supply of the steamers employed in the navigation of the Red Sea. Here, he adds, "are no deserts; but nations already prepared for improvement, and countries gifted by nature with a congenial climate, and with a boundless extent of virgin soil; where the indigo and the tea plant flourish spontaneously, and where the growth of the sugar-cane and of every other tropical production may be carried to an unlimited extent—regions producing grain in vast superabundance, and rich in valuable staples, cotton, coffee, spices, ivory, gold-dust, coal, peltries and drugs,—all, in fact, that is requisite to impart value and activity to exchange."*

* The Highlands of Ethiopia, by Major Harris.

KINGDOM OF SHOA.—HIGHLANDS OF ETHIOPIA AND SOUTHERN ABYSSINIA.

Coal.—A very recent authority, Major Sir W. Cornwallis Harris, in every way entitled to credit, who resided eighteen months in this country, as the head of the British embassy to its Christian capital, Ankober,—distant about four hundred miles west from the port of Tajúra on the Red Sea,—has communicated the interesting fact of the prevalence of coal in that part of the world. This traveller states, that coal beds appear to extend along the whole of the eastern frontier of Shoa; but that the combustible nature of the fossil is scarcely known or understood in the country.

Of the useful mineral products which prevail here, he adds, iron, sulphur, and coal, are the principal.*

Subsequently to the publication of the narrative from whence we derive the foregoing paragraph, has appeared a report to the East India Company from the same officer, with reference to the formation of a railway through the Isthmus of Suez.

In this document the author adverts to the highly important subject of the coal beds which have been reported to exist within a reasonable distance of the coast of Abyssinia; in a position the most convenient for supplying the depots, both at Aden and Suez.

NORTHERN AFRICA.

ALGERIA.

For the supply of this colony, France and England annually export a small amount of bituminous coal.

From France, in 1839, 1,590 tons. From England, in 1844, 17,564 tons; in 1845, 20,889 tons.

The geological constitution of Algeria affords no chance to discover the coal formation, at least in the cultivated zone. Researches have been made with this object by the French, and some persons have even pretended to have found certain indications. Very recently, however, some eminent geologists, commissioned by the French government, report the discovery of beds of coal in more remote parts of this colony. In short, it is asserted that coal and other mineral beds prevail, more or less, throughout Northern Africa.

France is desirous of establishing Algeria as a mining colony. It contains abundant iron ores of two descriptions; one resembling that of Sweden, the other, that of Elba. Wood will be used as the fuel for smelting, as there are at least 270,000 acres of forest land, capable of supplying many high furnaces.†

* The Highlands of Ethiopia, by Major Harris.
† Mining Journal, January 17th, 1846.

Lignites of Smendou, in the province of Constantine.—In the tertiary beds in the vicinity of Algiers, on the road to Doueira, the lower argillaceous series, as elsewhere, contain lignites, beneath a stratum of shelly limestone. Some pits have been sunk in exploring these lignites, but they have not exhibited very satisfactory results. At Coleah lignites occur in similar marls.*

This bed, which is extremely thin, is analogous to the lignite of the department of the Bouches du Rhone, and is, moreover, referred to the same formation, at the camp of Smendou. Notwithstanding its unimportant size, this lignite appears to be of good quality; and it will be interesting to make some researches in this locality. The formation is very limited, and has not been recognized elsewhere in this neighbourhood. What confers a greater importance upon any deposit of combustible whatsoever, is, that at Constantine, 13½ English miles to the north of Smendou, wood is extremely dear, on account of the clearing away of the trees in the surrounding country.† The beds of the Smendou lignites are situated above 19 miles from Constantine, and 37 miles from the sea. They are enclosed in a limestone of the tertiary formation.‡

A Marseilles newspaper published a letter from Tenes, in Algiers, stating that a vein of coal has been discovered on the banks of the Oued Allala, about a league from that place. The upper part of the seam is bad and will not burn; but the lower part is asserted to be of excellent quality. An application for a concession of the mine has been addressed to the government. If this mine prove a good one, the importance of its discovery cannot be overrated: for thus far the want of coal and wood has been considered an almost insurmountable impediment to the utilisation of the mineral wealth of Algeria, especially of its iron and copper; an object which the French government has much at heart.

Commenting on this flattering announcement, the *Journal des Travaux Publics* observes, "It is within our recollection that this pretended seam of coal has been discovered now three times. Authentic information enables us to reduce these reports to their just value. At three kilometres [nearly two miles] from Tenes, there certainly does exist a small seam of black schist, which has been excavated at different periods. This schist forms part of a slaty soil, and not a coal bed. It contains several laminæ, a few centimetres thick, of sulphurous *lignite*, of bad quality. This bed of ligneous schist has neither power nor extent."

It is now admitted that the pretended coal is merely a lignite, and of detestable quality, and is absolutely unfit for use, and that there is not sufficient coal in this colony to smelt the ores, which cannot, therefore, be turned to account.

MOROCCO.

The French government has had (1847) several mining engineers examining for coal and other mineral productions. As regards the latter, the investigation has hitherto proved unsuccessful.

EGYPT.

As no coal has been found in this country, its supplies are chiefly from England, and some from the south of France.

* Bulletin of the Geological Society of France, Vol. XI. p. 77. M. de Verneuil.
† Sur les Mines de l'Algérie, par M. Renou.
‡ Conte rendu des travaux, &c. 1846.

By a return to Parliament of coals exported from the United kingdom during the year 1842, it appears that Egypt received 7,260 tons, and 48,063 tons in 1845. During the discussions on the coal trade in 1831, it was then remarked that Newcastle coals were actually sold cheaper in Grand Cairo, than in London, as was the case in the Brazils. This anomaly was owing to the heavy home charges and duties, between the mines and the consumers in the metropolis; at that time pressing heavily upon the English coal merchants. These are now, in great measure, removed.

At Suez, we have recently seen it stated that the English coal, for the use of the steamers to Bombay, costs £4 10*s.*=$21.80 per ton.

We have been furnished by George R. Gliddon, Esq., late U. S. Consul, at Cairo in Egypt, with some statistics on this subject, for which we return our thanks, and subjoin their substance here.

Profitable contracts, between the Egyptian government and the English merchants have been made, from 1835 to 1840, at the rate of 7 paras the oke, for good English coal, landed and delivered to the government stores in Alexandria.

The imperial dollar was 20 piastres; each piastre 40 paras: so that the imperial dollar was 800 paras. This is equivalent to 8 paras to one American cent.

Seven paras are therefore seven-eighths of 1 cent = 0.87c.

The oke is 43 English ounces, avoirdupois, = 883 okes to the ton of 2240 lbs.

The cost to the Egyptian government at Alexandria is therefore $7.72: to which the government, in calculating the cost of coal per ton, for the pasha's steam engines, add charges, carriage, waste, interest, &c. &c., and charge each steam engine's consumption, in the government accounts, ten dollars per ton; all over Egypt, uniformly.

This is an arrangement as profitable to Mohamed Ali's government, as it is to the merchant who contracts to supply English coal, landed at Alexandria.

Ten dollars in Egypt are two hundred piastres. The English sovereign is 97½ piastres. The cost of English coal at Suez, for the steamers on the Red sea, being £4 10*s.* is equivalent to $21.95. Therefore, the charges of transportation of coal from Alexandria to Suez is at least $12.00 to the British government, above the $10.00 charged by the Egyptian government, and $13.25 more than the $7.72 received by the merchant of this, the camel line from the Nile to Suez, being $1.87½ for each load of 400 okes weight, is from $4.14, to near $5.00 per ton.*

The annual amount of coal heretofore required at Suez for the steamers is 2700 tons.

In 1842, a direct trade commenced between Egypt and Great Britain, as relates to coals. A large Egyptian ship, called the Ashereen, belonging to Mohamed Ali, commanded by Mahomed Saad, one of the Pacha's naval officers, her crew consisting chiefly of Egyptians, after delivering at Falmouth a cargo of Egyptian corn, proceeded to Port Talbot in South Wales, to load a cargo of "steam coal." This, it is said, was only the second Egyptian vessel that ever visited the shores of Great Britain.

Imports of British Coals into Alexandria.

According to evidence before a committee on the coal trade in 1838, it

* Geo. R. Gliddon, Esq., 1844.

is shown that English coals were then landed in Alexandria at the price of £2 4*s.* 6*d* = $10.75 per ton, on government account. Since that time, the export duty being taken off, the prices are lower. The Newcastle coals were sent out, because they were cheaper than the Welsh coal, which are much better steam coals.*

In the year 1842, 7,260 tons; 1843, 13,000 tons; 1844, 23,866 tons; and in 1845, 48,063 tons.

A small quantity commencing in 1842, has been imported from France.

English coal is likewise imported into Suez, via East India ports.

Recent search for Coal in Egypt.

For the last year, 1844, Mohammed Ali sent Hikekyan Bey [an Armenian colonel of engineers, educated in England,] along the deserts on both sides of the Nile, to search for coal. In this undertaking, although he went up as far as Khartoom on the junction of the Blue and White Nile, Hikekyan Bey was unsuccessful.† An English engineer has since been sent by the Pacha of Egypt, to make further explorations for coal in Upper Egypt.

A discovery has been made in Upper Egypt of several mines or beds of coal, in the Oasis of Ghenne, on the Arabic side of the Thebald. Several loads arrived at Syoat in the spring of 1846, from the desert, on their way to the lower province, whither they were sent for the Pasha's examination. This coal is stated to resemble the Scotch coal, and the discovery, should it prove as represented, will have some influence on this country, in her relations, both commercial and political, with England.

It has also been announced that Ayme Bey, an officer in the Pasha's service, has, after sinking several shafts, and several years perseverance, succeeded in reaching coal. We await more decisive intelligence ere we can credit the statements in circulation.

The geologists who were lately sent out by the Egyptian government on an exploring expedition into *Sinai*, in search of coal and other mineral products, reported the non-existence of the former.

In *Arabia Petræa*, so far as the examinations of the same party extended, there was not seen the slightest indication of coal formations.‡

Economical substitute for Coal.—In consequence of the great price of coal in Egypt, practical engineers have been led to the substitution of the refuse of cotton and cotton seed,—which formerly was thrown into the Nile, as useless, instead of bituminous coal. This substance, on account of the oil contained in the seed, is now used instead of coal for the Pacha's land steam engines and locomotives.

Nubia coal is reported to have been discovered, and specimens have been exhibited. The bed or mine is said to be situated on the borders of Nubia, in the vicinity of the first cataract of the Nile. Some additional machinery has been ordered from Europe, to enable the engineer to prosecute the inquiry with greater effect.§

Petrified Forests of the Egyptian and Lybian Deserts.

In the Suez desert, seven miles east by south from Cairo, is the district called the "Petrified Forest," which has been described by Lieut. Newbold.

* Report of evidence on the Port of London Coal trade, 1838, p. 114.
† Information furnished by George R. Gliddon, Esq.
‡ Mining Journal, 15th and 22d Nov. 1845. § Ibid.

It consists of a sterile, irregular plateau, considerably above the level of the Nile, and extends three and a half miles southwardly, and four miles eastwardly. Many silicified trunks are scattered over the surface, among rolled and angular fragments of dark grit, and pebbles of Jasper, chert, quartz, and sharp-edged fragments of petrified wood. The largest trunks occur in the greatest abundance on or near dark-coloured knolls; particularly towards the south-east portion of the area, where they lie like broken stems of a fallen forest, crossing each other at various angles; but the majority of the larger trees are directed towards the north-west. Two of the greatest, measured by the author, were forty-eight and sixty-one feet in length, and two and a half and three feet in diameter; but the lesser fragments are generally one to three feet long, and four to twelve inches in diameter. Among the fractured trunks which lay, broken transversely, on the sand hills, Mr. Newbold noticed many with their edges sharp, and in nice adaptation, though the fragments were several feet apart.

A few specimens are embedded, horizontally, in the sand and the associated conglomerate; and a still fewer occur in a vertical position, rising from 12 to 20 inches above the surface. The author cleared the sand from one of these stumps, and ascertained that its lower part was imbedded in the subjacent conglomerate; yet it exhibited no traces of roots.

The trunks, which are rarely flattened and never invested with coaly matter, are branchless, and in general knotless; though in some specimens could be traced the places for the insertion of branches. Roots also were wanting; but among the masses enclosed in the sand, some were found which bore strong resemblance to the bulbous bases of palms, and others which assimilated to the tortuous roots of exogenous trees. Internally the trunks exhibit a concentric structure, though externally they resemble the present palms of Egypt. Some specimens, examined by Mr. R. Brown, were decided to be *dicotyledonous*, but not *coniferous;* yet one brought from the Nubian desert is stated to exhibit that structure. Indications of a jointed appearance are mentioned, but Mr. Newbold is of opinion that this *calamite* or reed-like structure may be due to contraction during the process of silicification. Instances of decay, at the time the trunks were imbedded, the author also noticed; the interior being partly filled with grit and conglomerate; and he mentions cases in which all ligneous structure had disappeared. The silicified wood varies in character, from a white opaque crust, which crumbles, when handled, to agate and flint; and in colour from white to grey and brown.

No decided seed-vessels or traces of leaves have been found.

The following inferences are drawn by the author, from the phenomena, presented by the deposit of petrified trees:

1. He is of opinion that this part of Egypt has twice formed the bed of that ocean, and been twice elevated above the surface of the water.

2. That the fossil trees lived between these epochs, when they were submerged, or drifted into the ocean, and were covered up by a bed of rolled pebbles or sand; and that they were afterwards raised to their present position.

3. That the elevation of the strata was effected gently and gradually; as their horizontal position is maintained.

4. The retiring water is supposed to have removed the looser portions of the once continuous strata, and to have dispersed them, with fragments of the fossil trees, over the surface of the Egyptian and Lybian deserts; constituting the present accumulations of gravel and saline sands.

From the little worn aspect of the trunks, as well as from the angularity and "nice adaptation" of many of the fractured portions near Cairo, it is inferred, that, in that locality at least, the specimens rest at no great distance from the spot on which they were silicified; and from the vertical position of a few of the trunks, that they probably grew where they occur. But, until the vertical stems are traced down to roots fixed in a given stratum, or at certain levels, marking, as in the Portland "dirt bed," the ancient surface of dry land, the author hesitates to admit the hypothesis that the Cairo lignite deposit is the site of a submerged forest.*

We have made the foregoing copious extracts, almost in the original words of the writer, on account of the interest which attaches to the geological circumstances, and, in no slight degree, to the locality itself.

The dicotyledonous structure of the petrified trees of Egypt are, in some specimens, beautifully preserved. The pith, medullary rays, and circles of growth, are well characterized.†

MOKATTAM.

In the tertiary limestone formation on the shores of the Gulf of Suez, corresponding with the Calcaire Grossier, besides a multitude of well preserved shells, there occur fossil stems of monocotyledons and of palms.‡

WADY NATRÚN, OR VALLEY OF THE NATRON LAKES.

This interesting valley has been described by Sir J. G. Wilkinson. It contains eight lakes; four of them yielding common salt or muriate of soda, and four which produce the natron or carbonate of soda. In length it is about twenty-two miles, and from two to five and a half miles broad.

The hills which separate Wady Natrún from the valley of Bahr-el-Fargh, [empty river,] are covered with pieces of petrified wood. These agatised woods are mostly palm; a knotted tree, perhaps of a thorny kind, and a pointed stem, resembling a cane; precisely the same as those that are found on the opposite side of the Nile, on the summit of the Mokattam range behind Cairo. They have probably been imbedded, with pebbles, in a friable layer of sandstone, which having been decomposed, has left these heavier bodies upon the surface of the stratum next beneath it; while its lighter particles, carried off by the wind, have contributed not a little to increase the quantity of sand in these districts.§

EASTERN AFRICA.

ISLAND OF MADAGASCAR.

Coal has been frequently reported to exist in this island; but we are in possession of insufficient data, to enable us to confirm or describe it. It

* Proceedings of Geological Society of London, Vol. III. p. 782.
† Mantell, Medals of Creation, Vol. I. p. 70.
‡ Bulletin de la Societé Géologique de France, tom. XI. p. 67.
§ Journal of Royal Geographical Society of London, Vol. XIII. 1843, p. 113.

probably belongs to the carboniferous period, as the old red sandstone abounds; and recent travellers speak with decision as to the presence of coal formations. There seems, therefore, no reason to doubt that the true coal formations prevail in Madagascar; a fact the more interesting, both in a commercial and geological sense, since it has so frequently been asserted that no coal exists in or near the continent of Africa. We now possess evidence that it does exist in several extreme points; from the Cape of Good Hope to Mozambique,—without mentioning the adjacent Madagascar,—to the high regions of tropical Africa, Ethiopia, and Southern Abyssinia.

With the coal strata occurs an abundance of good iron ore. The working of iron, next to the cultivation of the soil, is the most important occupation of the people. It is collected in large quantities near the surface, and is smelted by means of charcoal, in rude furnaces of stone-work, built up to the height of two or three feet, without mortar, and thickly plastered with clay on the outside. Numerous articles of use are manufactured from this iron, by the natives. The felling of the timber employs about seven hundred men.*

This iron is ascertained to be meteoric; and the natives exhibit great skill in the conversion of it into various implements, fish-hooks, spears, &c. They have a high opinion of the superior value of their own iron to that of any other, and affirm that it exists in large masses, in a pure and malleable state.

Professor Shepard's analysis of a specimen brought from hence by Lieut. Flagg, showed that it contained 96 per cent. of iron and 3.34 of nickel.†

MOZAMBIQUE.

If the recent announcement that coal exists on the east coast of Africa, be correct, it is a fact of no small importance in geological and mineral statistics. "At Vilimané, a place in the Portuguese settlement of Mozambique, a short distance to the south of that town, a discovery, it is stated, has been made of some valuable coal seams.

This is a circumstance of great interest, not only to the Portuguese, but to the British inhabitants of India; as it will tend to insure a supply of that necessary article, not only to the steamers of the Indian ocean, but also at Oden and in various parts of the Red Sea. Specimens of it were sent to Bombay."‡ Whatever be the nature of this coal, it appears to occur on the same parallel with that which prevails in Madagascar.

SOUTHERN AFRICA.

CAPE OF GOOD HOPE.

Brown Coal.—An experiment of boring, in search of coal, took place under the government of Lord Macartney, at Wynberg, a tongue of land

* McCulloch—Geographical Gazetteer—also "Documens sur le Commerce exterieur," Octobre, 1844.
† Proceedings Assoc. Amen. Geol. April, 1845, p. 40.
‡ Morning Herald, Jan. 1841.

projecting from the Table Mountain. The depth penetrated was 128 feet, consisting of clay, soapy rock, and brown and grey sandstone, including two feet of coal.

A stratum of coal, found on the banks of a deep rivulet, flowing out from the *Tigerberg*, (a hill that terminates the isthmus from the eastward,) was horizontal, having a super-stratum of pipe clay and white sandstone, and a substratum of indurated clay. The coaly *seam*, from ten inches to two feet in thickness, differed in quality at various places—sometimes it was in large ligneous blocks, with visible traces of the bark, knots, and grain of timber. In the midst of these were iron pyrites, running in crooked veins, or lying in irregular lumps. Other parts of the stratum consisted of laminated coal of the nature of turf, burning with a clear flame, and leaving a light white ash. The more compact and heavy coal gave a sulphurous smell, and left a slaty coke with an ochreous crust.

A vein of coal has recently been discovered near the mouth of the *Kroom river*, which is accessible to small craft.*

There can be little doubt but these seams belong to the class of Brown coals, and are probably not older than the tertiary period.

PORT NATAL.

Coal.—This country has recently been annexed to the colony of Good Hope. It includes the territory between the Tugula and the Umsinjaati or Buffalo river; thereby securing the only eligible means of communication with the interior. What renders the treaty doubly valuable is, that the ceded country is said to abound in coal, which is found exposed along the banks of several streams within that region. It is probably a continuation of the coal said to abound in the Mozambique, and to extend over into Madagascar.

Mr. J. R. Bakewell is of opinion that extensive veins of coal exist at about 500 miles east of Cape Town.†

CAPE DE VERD ISLANDS.—[PORTUGAL.]

Petroleum floats on the waters which issue from the volcanic mountains, or which lie at their base. Even the sea is, at times, covered with it, in the vicinity of the Cape de Verd Islands.‡

KERGUELEN'S LAND, [DISCOVERED IN 1772.]

This solitary island, for the most part of volcanic origin, lying midway between the Cape of Good Hope and Australia, in longitude 67° E., and latitude 48° or 49° S., has been found to contain mineral coal. The circumstance has been reported upon by Captain McCormick, R. N., to the Royal Society of London, April 20th, 1841.

The occurrence of this fuel here is of great importance, from the peculiarity of its situation, in aid of steam navigation. Captain McCormick states that the coal is situated among igneous rocks. If so, it is probably in the state of anthracite. Of its geological age we have no information.

There appear to be two descriptions of mineralized vegetable matter upon the island. 1. Fossil wood or lignite, for the most part highly silicified, and inclosed in basalt. 2. The other substance is described as genuine

* Colonial Statistics of the British Empire, Martin, p. 475.
† Mining Journal, August 15th, 1846.
‡ Ure's Dictionary of Arts, &c.

coal; cropping out in the ravines, and in close contact with the overlying porphyrite and amygdaloid greenstone.*

One of the fossil trees, seven feet in circumference, was sent by Captain Ross, to England.

In the "Tasmian Journal," quoted by the Rev. W. B. Clarke, is an account, Vol. 1. p. 27, by Dr. McCormick, surgeon of H. M. S. Erebus, of silicified wood, found in association with trap rocks in Kerguelen's Land; apparently referring to the same fossils mentioned in the last paragraph.†

Some of the pieces of fossil wood, says Sir James Ross, whose expedition remained on the island for two months, in 1840, appeared to be so recent, that it was necessary to take them into your hand to be convinced of their fossil state; and "it was curious," he observes, "to find it in every stage, from that of charcoal, lighting and burning freely when put in the fire, to so high a degree of silicification as to scratch glass. On the south side of the harbour there are two seams of coal, one of which is 150 feet long and four thick, and another, further east, about thirty feet long and three feet thick."

* Mining Journal, Vol. II. p. 214.
† Tasmian Journal—Van Diemen's Land.

ASIA,

COMPRISING

1. TURKEY IN ASIA.
2. CAUCASUS AND GEORGIA.
3. ARABIA.
4. BRITISH ARABIA.
5. PERSIA.
6. WESTERN PERSIA.
7. AFFGHANISTAN, EASTERN PERSIA.
8. KHORASSAN, NORTHERN PERSIA.
9. TARTARY.
10. THIBET.
11. JAPAN.
12. HINDOSTAN—EASTERN BENGAL—NORTHERN BENGAL—UPPER OR NORTHERN HINDOSTAN—KINGDOM OF NEPAUL—BENGAL—BOMBAY.
13. TURKESTAN, OR INDEPENDENT TARTARY, CENTRAL ASIA.
14. KHOKAN, OR FERGHANA.
15. NORTHERN HINDOSTAN.
16. BIRMAN EMPIRE.
17. BIRMAH.
18. FARTHER INDIA.
19. MALAY.
20. MALAYAN PENINSULA.
21. EAST INDIA ISLANDS.
22. SIBERIA.
23. CHINA.
24. ARCTIC OCEAN.

ASIA.

TURKEY IN ASIA.

Area, about 437,000 square Br. miles; population, about 10,000,000 persons.

ANATOLIA.

At *Heraclea*, or Erekli, about one hundred and fifty miles east of Constantinople, on the south shore of the Black Sea, is a formation, supposed by Professor Hitchcock, from the specimens procured, and from geological information obtained, to be "genuine bituminous coal." It is said to be of considerable extent, and being of excellent quality, and, so near to Constantinople, possessing withal many facilities for transportation, in ordinary cases, its value would be exceedingly great.

The following is the analysis of one hundred parts.*

Carbon,	62.40
Volatile matter,	31.80
Earthy matter,	5.80

A company, called the Erecli Coal Company, to consist of Ottoman subjects only, has been formed to mine coal; but the project remained for some time unprofitable.†

By accounts from Constantinople, at the close of 1844, we were apprised that these coal mines have been put in operation, and are said to yield fuel equal to the English coal.‡

Two thousand tons of this coal were mined in 1840; the coal proved of excellent quality, and likely to be of great service to the Turkish government. It has been successfully used by the steam ships.

The port of *Pendarackia* is one of the finest in the possession of the Turkish emperor. A coal-field was found here in 1840. A Turkish steamer was soon after sent to examine the place, and bring back specimens of the mineral; and she employed the coal on the voyage from Constantinople, for the purpose of generating steam. It is an important discovery for the steam navigation of the Black Sea.§

On the borders of the Black Sea, coal was discovered, in 1844, and was submitted to scientific examination, with favourable results.

The Ottoman government, at the suggestion of M. O. Dardain, Director of the Government Powder Works, has engaged the services of Mr. Clay,

* Professor Hitchcock in Transactions of the Association of American Geologists and Naturalists, 1843, Vol. I. p. 392.
† October, 1841.
‡ Mining Journal, 23d November, 1844.
§ Mining Review, 1840, p. 55.

in making iron in Turkey, according to his process of reducing rich ores into malleable iron.*

SYRIA.

Asphaltum or Bitumen is in great abundance on the shores of the *Dead Sea;* furnishing the greater part of the asphaltum of commerce.

In its black colour and fracture it resembles ordinary pitch. Its average density is 1.16. In all other essentials it appears to resemble the chapapote of Cuba.

That part of Professor Hitchcock's Notes on the Geology of Western Asia, wherein he treats at some length on the bituminous limestones and asphaltum of the Dead Sea, and his geological speculations induced by the present state of scientific knowledge as to the former and existing condition of the interesting sea of Judea, is deserving of a more extended notice than can be given to it here.†

The asphalt of the shores of the Dead Sea, "Lake Asphaltites," in Judea, is commercially known under the name of *Bitumen Judaicum*, or Jewish Pitch.

The ancients employed bitumen in the construction of their buildings; the bricks of which the walls of Babylon were built, were, it is said, cemented with hot bitumen, which gave them unusual solidity.‡

MOUNT LEBANON.

Compact Bitumen—Supposed Coal.—There are coal mines on Mount Lebanon, worked under the orders of the Pacha. Dr. Bowring, in 1838, described their character somewhat unfavourably; they being badly ventilated and difficult of access. The number of workmen then employed was one hundred and fourteen, who were paid three piastres each, equal to 7½ pence per day, or 15 cents. They work in two relays, day and night.

The galleries enter the mountain horizontally. The quantity of coal extracted in 1837 was 14,700 cantars of 217 okes each, making about four thousand tons.§

Professor Hitchcock, in 1843, furnished some analysis of this supposed bituminous coal, showing that it possesses an extraordinary proportion of volatile matter.

Carbon, - - - - -	24.40	per cent.
Bitumen or volatile matter, - -	68.00	"
Earthy, incombustible matter, - -	7.60	"
	100.00	

This excessive quantity of volatile matter led the Professor to hesitate admitting it among the bituminous coals, and rather to regard it as a variety of asphaltum.

A specimen of true asphaltum from Mount Hermon, which is a part of anti-Libanus, gave the following results:

Carbon, - - - - - -	14.00	per cent.
Bitumen or volatile matter, - - -	72.60	"
Earthy residuum, - - - -	13.40	"
	100.00	

* Mining Journal, January, 1844.

† Reports of the meetings of the Association of American Geologists and Naturalists, Vol. I. 1843.

‡ Dictionary of Commerce, p. 133.

§ Dr. Bowring on the Commercial Statistics of Syria, 1840, p. 20.

At all events, he appears to come to the conclusion, that these deposits of bitumen can have little bearing upon the question of the age of the rocks containing them; for those are probably of volcanic origin. The character of the lignites occurring in the same series, at Brumanah on Lebanon, is not different from that of common lignites; and the accompanying shales are merely friable clay, impregnated more or less with carbon.*

The Syrian coal mines of Mount Lebanon are from twenty-six to thirty miles eastward of Beyrout, at an elevation of upwards of 2,500 feet above the level of the sea. There are traces of coal in various parts of the mountains. The seams, on an average, are three feet thick.† Some veins are four and a half feet thick; but all appear to be highly sulphurous. Smelting furnaces have been erected near the coal, for working the iron ore of this neighbourhood, but their returns are quite insignificant.‡

Mr. Gliddon, late United States Consul at Cairo, in Egypt, has communicated to us some information as to the investigation of the Mount Lebanon coal.

After the conquest of Syria by Mohamed Ali, in 1831–2–3, an English mining engineer, Mr. James Bretell, came out from Cornwall, and examined the coal regions of Mount Lebanon. That gentleman opened and worked several drifts, &c., particularly in the vicinity of the Orontes. The coal taken out was sent to Egypt for trial, and each engineer was ordered to try it in his steam engine.

Mr. Bretell continued his operations in Syria, from 1833 to 1837; when, in consequence of the Syrian coal being condemned and absolutely rejected by every engineer in Egypt, the mines were abandoned by him, and he came to Egypt, and resided there until 1840, when he left the service and returned to England.

The complaints against the Syrian coal are as follows: The great abundance of pyrites or sulphuret of iron, was found to destroy all the iron with which it was brought into contact; and several boilers, grates, &c. were ruined. Finally, there was no conceivable purpose to which it could be appropriated, save for the limekilns; but even for that it could not be economically applied, because other and far cheaper fuel was at hand. Its use, therefore, was entirely abandoned in Egypt.

Since 1840, the Pacha, having lost all control over Syria, can procure no Syrian coal; and the Turks have abandoned the subject, because the coal mines at Heraclea, on the Black Sea, near Constantinople, would afford an abundant supply of first rate bituminous coal, if the supineness of the Turks had not led them to refuse all European offers for working those mines.

A box of Syrian coal was delivered by Mohamed Ali's order, to Mr. Gliddon, when he visited the United States of America. This coal was tested by Professor Renwick, of Columbia College, New York, and also by several practical engineers, at the West Point foundry. It was there condemned, as unfit for any purpose, and Mr. Gliddon reported the interesting fact to the Pacha of Egypt, on his return.

* Reports of the meetings of the Association of American Geologists and Naturalists, Vol. I. 1843.

† Mining Journal, 1837, p. 87.

‡ McCulloch's Dictionary of Geography, Vol. II. p. 156.

CAUCASUS AND GEORGIA.

This country originally belonged to Prussia, but was acquired by the Russians.

PROVINCES OF SHIRVAN AND DAGHESTAN.

Towards the east end of the Caucasian chain, in the peninsula of Abskharon, bordering on the Caspian Sea, is an extensive bituminous coal formation, [brown coal,] comprehended in a ridge of argillaceous shale, which forms the bulk of the Province, and extends into Georgia. At the town and promontory of Bacou, or Badku, on the Caspian, in this district, wells of naphtha, used by the fire-worshipers, are abundant.

The inhabitants of Badku have neither fuel nor lights, except what they derive from this substance; but it yields much smoke, and a disagreeable smell.

This formation re-appears, in the Isles of Naphtha, on the opposite or eastern shores of the Caspian.

"The quantity of naphtha procured in the plain to the south-east of the city of Baku or Badku, is enormous. It is drawn from wells, some of which have been found to yield from 1000 to 1500 lbs. a day. These wells, in a certain sense, are inexhaustible; for they are no sooner emptied than they again begin to fill, until the naphtha has attained its previous level."

East of the naphtha springs is the fire-temple of the Ghebers. Here arise strong jets of inflammable gas, which readily burst into flames, and the whole country around is at times lighted by these natural gas lights.*

The island of Wetoy abounds also with naphtha.

CRIMEA.

Naphtha or Rock Oil.—Near the western extremity of the Circassian or Caucasian range, in the peninsula of Kerch, at the entrance of the sea of Azof, and on the peninsula of Taman, on the eastern side the passage, a bituminous formation exists, and springs of naphtha prevail. This is evidently a continuation of the same bituminous range as that we have described above.

ARABIA.

We have no tokens of coal in this country; but in the vast mountain range, which skirts the Red Sea, bitumen and petroleum are exceedingly abundant, in strata wholly composed of oceanic animal matter. It is secreted even in the larger fossil shells, in the cavities of stones, and in the hollows of rocks; in beds of the calcareous hills; and sometimes exuding from fissures and abrupt declivities, caused by the intense heat of the climate.

* McCulloch, from Kinneir's Persia, p. 359.

BRITISH ARABIA.

Aden.—The great depot for coal for the steamers up the Red Sea, and to *Bombay*. This is a volcanic country; the coal is brought from *Southern India*. Aden is the seat of an extinct volcano.

PERSIA.

Estimated area of the Persian Provinces, 482,130 square miles, having a population of 11,230,000 persons.

Bitumen, petroleum, and naphtha, are found in all the countries bordering on the Tigris and Lower Euphrates; they serve as cement, as pitch for lining the bottoms of vessels, and as a substitute for oil.

WESTERN PERSIA.

Bitumen Pits in Susiana, now Koordistan.—Major Rawlinson, in 1836, visited what he was led to consider the site of the Eretrian Colony of Ardericca, examined by Herodotus. The liquid bitumen is collected, at the present day, in the same way as is related by Herodotus, about 2280 years ago. There are positively no bitumen or naphtha pits in all Susiana, but at this place, and near Ram Hormuz; a fact which materially assists in identifying the ancient site referred to.*

Petroleum is particularly abundant in Persia. "When taken from the pit, it is a thick liquid, resembling pitch. The bottoms of most vessels that navigate the Euphrates and the Tigris are covered with this pitch, and it is also used in lamps, instead of oil, by the natives."†

Fars or *Farsistan*, in Western Persia, on the borders of the Persian Gulf. There are some very productive springs of naphtha in this province.

AZERBIJAN PROVINCE, OCCUPYING THE NORTH-WEST ANGLE OF PERSIA.

Coal is reported to prevail in the mountainous part of this country; probably a continuation of that of Northern Persia, south of the Caspian Sea. Of its character and properties we know little. Naphtha is stated to be abundant and applied to useful purposes.

* Journal of the Royal Geographical Society of London, Vol. IX. Part 1.
† Kinneir's Persian Empire, p. 39 and 359.

AFFGHANISTAN, EASTERN PERSIA.

KINGDOM OF CABOOL OR CAUBUL.

Bituminous Coal Formations.—In the upper part of the Bolan pass seams of coal were observed, by Major Sotheby, laid bare by the erosion of the water.

Lieut. Burnes, in 1833, described bituminous coal, as occurring high up the Indies, to the westward, in the district of Cohat, and below Peshawur.

Under the direction of Sir Alexander Burnes, coal was found immediately on the west banks, and also farther westward, of the Indies, from *Kala Bagh*, in no less than twelve localities.

It was found close to the towns of Shukurdura and Muckud, stretching in the direction of Cohat, towards Ghuzni, in Cabool, along the salt range, after it has crossed the Indus, and lower down at Kaneegoorum.

The coal was intersected by deep ravines and channels of torrents, by which means it was examined without difficulty.

Mr. J. Princep, in reporting to his government on this coal of the western bank of the Indus, stated that "four of the specimens were, in fact, of the very finest form of mineral coal; that in which all vegetable appearance is lost." Of one of the specimens, a kind of jet, he remarked, that "if found in sufficient quantities, it would not only answer well as a fuel, but be superior to all other coals, for the particular object of getting up steam, from the large proportion of inflammable gas it disengaged under combustion."*

From the head of steam navigation, on the Indus, at Kala Bagh, the Parsee merchants communicate, by land conveyance, with Cabul, supplying the wants of that city. It appears that coal prevails over a large portion of the intervening space.

Territories of Candahar and Seistan.—Coal exists here.

District of Cahut.—Coal, naphtha and petroleum.

KHORASSAN—NORTHERN PERSIA.

South of the Caspian Sea, between Teheran and Demavend, a coal formation was described, in 1838, by Dr. Bell and Major Todd. In the bed of the river Dalee Chaée are upraised beds of "altered shale, like coked coal."

On the north side of the range of Elboorz mountains, a similar coal formation was strongly displayed.

Anthracite near Bulkhulum, a precipice nine hundred or a thousand feet high, consists of perpendicular seams of coal and beds of sandstone, of which two materials the entire hill or mountain is composed.

* Sir Alexander Burnes' Narrative of his residence at Cabool, p. 113.

Near *Karoo*, a few strata of coal are visible near the top of the precipice; showing the continuation of this formation, westward, along the north flank of the Elboorz range.

It would appear, from the notes of these travellers, that the northern coal-field was at least ten miles wide, and sixty or eighty miles long, in an east and west direction; neither termination being known. Being situated in the midst of a trap region, the position of the strata have undergone unusual disturbance; and the coal itself has been converted into a substance having the characters of anthracite, but whether of secondary or tertiary origin is not explained.

The Schah of Persia has lately granted to a Russian company, for a certain rent, the working of the extensive and excellent coal mines of Masenderaz, discovered by Major Workobonikoff, in 1840.

In the "Desert of Black Sands," bitumen gives colour to these sands. Petroleum abounds in the Province of Kerman, towards the Persian Gulf.

TARTARY.

Koondooz.—Beyond the northern side of the lofty Hindoo-Koosh granite range of mountains, or western prolongation of the Himalayan chain, towards the sources of the Oxus, at Kobal, Dr. Lord procured specimens of coal.*

Coal has long ago been well known in many parts of Tartary, where its use is not only mentioned by Marco-Polo, but by many early writers.†

THIBET.

Lignite.—Without being able to designate the particular localities, we have at present to note, that lignite occurs in that vast and lofty secondary region, which lies to the north of the primitive Himalayan range.‡ It is extremely probable that this deposit is of the same geological age as that zone of lignite which occupies the southern plank of the Himalayan range, and which stretches from China far into Europe.

JAPAN.

Much coal is wrought: we are without details.

* Narrative of Sir Alexander Burnes, p. 113.
† Mining Journal, Vol. XII. p. 66.
‡ Asiatic Researches, Vol. XVIII.

HINDOSTAN.

	En. sq. m.	Population.
Area of Paramount or British States,	512,873	83,473,417.
Tributary States,	564,610	41,278,092.
Total,	1,077,483.	124,751,509.

Weights referred to in this Section.

The Maund of Madras = 8 ris = 40 seers = 25 lbs.
The Bazar Maund of Bengal, of 40 seers = 82 lbs. English, 82 lbs. 13 dec.
The Maund of Calcutta, 84 lbs. = 26.66 maunds to 1 ton of 2240 lbs.
The Factory Maund of Bengal, $74\frac{2}{3}$ lbs., 74 lbs. 67 dec.
1 Lac of maunds, 683,300 lbs. = 305tons, of coal.
20,000 maunds of coal, 750 tons, nearly.
$26\frac{60}{100}$ maunds [*commonly called 27 maunds in coal measure*] 1 ton.
The Candy, of 24 maunds of Madras = 500 lbs.
The Madras Garee, for grain = 12.8 mds.

Measures at Bengal, &c.

Three Jows or barley corns = 1 Finger; 4 Fingers, 1 Hand; 3 Hands, 1 Span; 2 Spans, 1 Cubit; 4 Cubits, 1 Fathom.

1 Cubit, $19\frac{1}{4}$ inches,* being the mean measurement at 24 different parts of India.

1 Coss, 1 mile and $\frac{1}{8}$th, $\left\{\text{1 mile, 1 furlong, 3 poles, } 3\frac{1}{2} \text{ yards = 1000 fathoms.}\right.$

1 Coss, 1000 fathoms of 6 feet each.
At Madras, 1 mauney = 2400 square feet.
The Cawney = 24 mauneys = 1.3223 acre.

In Tavoy and Mergui, Aracan, two kinds of cubits are used. The Tendam of 18 inches, and the Saundaum, or Royal cubit, of 22 inches. The King's cubit is only used for measuring the crown lands.

Money.

1 Rupee, 1*s.* 10*d.* English = $0. 44, United States currency.
1 Sicca Rupee, 2*s.*
1 Lac of Rupees = 100,000 Rupees = £10,000, sterling.
1 gold mohur, £1 13*s.* $2\frac{1}{2}$*d.*

The 1 lb. Troy of standard gold [$\frac{1}{12}$th alloy] is coined into 28.13 Gold mohuns of India, 32.00 Madras and Bombay mohuns, 46.74 English sovereigns.

1 lb. Troy of standard silver [$\frac{18}{240}$ths alloy] is coined into 32 Company's Rupees, 66 English shillings, £3*s.* 6.

1 Kilogramme of French standard silver [$\frac{1}{10}$th alloy] is coined into 200 francs.

* The length of the cubit, practically, in India, almost everywhere, is determined by the mean length of five different men's arms, measured from the elbow to the end of the middle finger.

100 Sicca Rupees are equivalent to 250 francs at the Paris mint.
100 French francs are, 38.673 Sicca rupees, deducting duty.
100 Napoleons, or 20 franc pieces = 53.227 Madras and Bombay gold rupees.*

1 Gold rupee of Bombay = \$7.09.6, U. S.†
Of Madras = \$7.11 U. S.

Pagoda = Star, \$1.79.8. U. S.

Exportation of British Coals to the East Indies.

The East India Company contract for supplies of coal for their steam navigation, delivered chiefly at Bombay, Calcutta, and Aden. It consists of what is termed "Welsh steam coal," semi-bituminous or free-burning anthracite. The Llangennech coal was shipped on board, for the East India contracts, in 1838, at 11*s.* = \$2.67 per ton, selected or hand-picked.

In 1847, the Directors of the East India Company proposed to receive contracts for 25,000 to 30,000 tons of hard splint coals, screened, such as those of Glasgow, Hartlepool, West Hartley, &c.

The indigenous coal of India, although of good quality for railway and other purposes, is not suitable for steam navigation. Consequently, the company is obliged, until more advantageous deposits can be found, to contract for British coal for their steam packets, which run to and from Suez to Bombay, Madras, and Calcutta, and also for their steam navy.‡

The quantities of coals exported from Great Britain to all places eastward of the Cape of Good Hope, (except China;§) chiefly Hindostan and Ceylon, —in the year 1830, 4,043 tons; in 1831, 5,056; in 1832, 6,473; in 1840, 33,053; in 1841, 63,920; in 1844, 28,231; and in 1845, 85,689 tons.

By the act of 1836, coal is admitted free of all duty, whether imported in British or foreign bottoms, into any part of the Presidency of Fort William, in Bengal.

Indigenous coal, of the bituminous species, has already been discovered in more than one hundred localities in Hindostan; the best being that of the Nerbudda and Burdwan districts, and the region above Sylhet.

WESTERN INDIA, PROVINCE OF CUTCH OR KUTCH.

Oolitic Coal.—Coal discovered long since by Captain McMurdo, and reported on by Sir Alexander Burnes, in 1833, appears near the mouth of the Indus. In 1837 its geological position was described by Captain Grant.

This gentleman's geological map shows that the coal district extends parallel with the coast line, north of the Gulf of Cutch, for two hundred miles in length, and averages about twenty miles in breadth. The formation consists of sandstone and slate clay, with bands of iron ore and seams of coal, which, so far as proved, do not appear to exceed eighteen inches in thickness, each. At present, neither the quantity nor the quality of this coal afford much encouragement for prosecuting further researches, at least for some time to come.

It consists of cubical masses, in no respect resembling lignite: it ignites quickly, and burns with a bright flame.

From the character of the vegetable remains, Captain Grant assigns the age of this formation to that of the oolitic coal of England.

* The Hand Book of India, 1844, pp. 65–66.
† Bicknell's "Gold Coin Chart."
‡ Mining Journal, Dec. 29th, 1846.
§ McCulloch, Dictionary of Commerce, 542; and subsequent returns.

With this opinion Colonel Sykes appears to coincide, in a memoir published in the same Vol. V. of the Geol. Trans.

Formerly the government worked this coal.*

The existence of mineral coal in the province is of some importance, because the country is generally bare of wood; and although, like the Yorkshire coal, it is of second rate character as a combustible, yet, under the circumstances, it is not without its comparative value.

PRESIDENCY OF BENGAL, EASTERN INDIA OR CALCUTTA DIVISION.

District of Cuttack, on the coast of Coromandel.—Coal is mentioned here by Mr. Calder, and is thought likely to be productive.†

SOUTH-EASTERN INDIA.

At the French settlement of *Pondicherry*, and other places in south-eastern India, silicified wood abounds in red sandstone. This fossil wood exhibits no traces of worm borings, and occurs in the form of trees denuded of their barks; some of them being as long as a hundred feet, and all apparently *coniferæ*.

Over this red sandstone occurs fossiliferous limestone, apparently secondary, accompanied by calcareous wood, bored by teredo.‡

SOUTHERN INDIA.

Travancore.—Indications of coal are said to prevail.

PROVINCE OF PUNJAB, EAST SIDE THE INDUS.

At Jummoo, anthracite was discovered in 1842, under the supervision of Sir Alexander Burnes, high up on the Chenub river, an eastern branch of the Indus.‡

The coal formation on both sides this river preserves about the parallel of 32° North Lat., and the strata range about east and west.

PROVINCE OF PUNJAB OR LAHORE.

The Indus is navigable, by the enterprising Parsee merchants of Bombay, in steam vessels, as far as *Kala Bagh*, eighty miles below Attock. At three places on the eastern bank, between Pind Dadun Khan and Kala Bagh, and at other points at distances from twenty-five to fifty miles of the river, Lieut. Wood was fortunate in discovering coal.§ In these localities the coal was found under similar circumstances, viz., in deep dry water-courses, and in the channels of winter torrents.||

In the verge of the mountains, towards Mundi, some mines of coal have been ascertained, forming, no doubt, a continuation of the great coal region which crosses the Indus into Cabool.

Attock.—A coal-field occurs on the east side of the Indus.

CENTRAL INDIA, PROVINCE OF ALLAHABAD.

Bundelkhand, the Diamond region of Pannah, east of the Kén river.—Capt. Franklin states that in all the ravines horizontal beds of black bitu-

* Trans. Geol. Soc. of London, Vol. V.
† Asiatic Researches, Vol. XVIII. p. 11, 1829.
‡ Mr. Kaye, Proceedings Geological Soc. Lon., Vol. IV. p. 204.
§ Sir Alex. Burnes' Residence at Cabool, p. 113, 337.
|| At Joal, Meealee, and Nummel.

minous shale are observable. They readily flame when ignited, and he was disposed to think that coal was not far distant. These beds appear to form the lower part of what he considered the equivalent to the new red sandstone. The author had no means at hand for practically determining this question. This sandstone occupies a considerable area in central India, and if coal should be proved to exist and be coextensive with it, such a fact would be of great importance. Capt. Franklin appears to view these lower bituminous beds as of the true coal formation, having four hundred feet or more in thickness of sandstone, upon which the *diamond mines* are sunk, in red ferruginous gravel or conglomerate.*

The *Nerbudda Coal district*.—In Captain Coulthard's geological map of the Sagar or Saugoor district, we find notices of coal traces occurring along the south side of the Nermada river.†

According to Professor Ansted's Report to the Indian government, in 1846, coal occurs here in three positions, at about 350 miles from Bombay; the most important being that near Gurrawarra, about midway between Hoosingabad and Tubulpore. This coal is perhaps the best yet found in India. It occurs in three seams, of twenty feet, forty feet, and twenty-five and a half feet, respectively, besides other beds, of which one is four feet thick.

The coal-field exists about twelve miles south of the Gurrawarra, at the foot of the hills.

The *Benar* coal-field, Nerbudda district, promises to be of great importance. Near it is also another coal basin, where, among other beds of excellent quality, is one of twelve feet thickness.

At Fatephur [Nerbudda] coal exists, but is earthy.

PRESIDENCY AND PROVINCE OF BENGAL—CALCUTTA DIVISION.

Burdwan or Damuda Coal-field.—About 130 iles mnorth-west of Calcutta, and nearly under the Tropic of Cancer.

The Asiatic Researches, for 1833, contain a geological map and description of this region, by Mr. Jones. It is the most complete illustration we possess, up to that period. From this it appears that, in 1774, Mr. Heatley, a political agent in the district of Beerbhoom or Burdwan, forwarded about two thousand maunds, say 164,000 lbs., or 73 tons, to the arsenal at Calcutta, from a village called Aytura, near which the excavations are still visible. This cargo was not, at the time, approved of.

After these works had been neglected for above forty years, the coal-beds of the Burdwan district were again explored, in 1815, by Mr. Jones. Several shafts were sunk under his direction along the banks of the river Damuda. He traced the coal measures for sixty-five miles in one direction—its breadth appearing to be about twenty miles. This formation is based upon granite and other primary rocks, and is traversed by a large whin-dyke. The coal strata also contain iron ore.

Mr. Jones's principal shaft, in 1816, was eighty-eight feet deep, passing through eight beds of coal—the largest being nine feet, and the smallest four inches—in all, twenty-four feet eight inches of coal. He considered the coal to be of good quality—its cleanliness rendering it peculiarly adapted for culinary purposes. It resembled, somewhat, the Sunderland coal; but

* Capt. Franklin, on the Diamond Mines of Panna; Asiatic Researches, Vol. XVIII.
† Asiatic Researches, Vol. XVIII.

after burning left more cinders and ashes. It was used in the smitheries and steam-engines at Serampore.

A second colliery was established in 1826, when the Burmese war found constant employment for the Enterprise steamer, the first steam-vessel that made the voyage out from England to India. Since that time there has been a regular increase in the demand for this coal.*

Situated as the Burdwan coal-field at present is, it is obvious that the expense of transportation is heavy—being estimated at nearly one half of the selling price at Calcutta. The Damuda river, it is proper to observe, is not navigable more than ten weeks in the year.

Mr. Jones speculated upon the probable extension of this coal formation entirely under the great Delta of Bengal, to join the Sylhet coal region in Assam, and even into China. He adduced no geological evidence for such an hypothesis. The interval between these two points is three hundred and seventy miles; but, independently of this, a conclusive objection is found in the fact, that they are of different geological ages—that of Sylhet being now known to be tertiary.

Captain Herbert classes the Burdwan coal with those that burn with much flame, but do not coke—the refuse being a light ash.†

In the Ramjung colliery of this district, several seams have been proved; but they are not all found to be workable.‡ Experiments, made upon this coal, show that it is by no means of the first class, and that it contains a good deal of earthy impurity.§

Still, the rapid increase in the number of steam-engines on land, and the equally rapid extension of steam navigation, both on the rivers and by sea, have led to a corresponding demand for mineral fuel. The first coal that was sent down and submitted to trial, was evidently an inferior sample, taken, as usually happens, from near the outcrop. At the present day, it is in constant use for factories, cotton mills, flour mills and foundries, for the mint in Calcutta, and at numerous private establishments. Within three years, prior to 1840, 250 fire grates and stoves were fitted up at Calcutta, for burning this coal.‖

In 1831, an English company employed at their mines here from two thousand to three thousand natives, and three or four hundred boats to convey the fuel to Calcutta. It is also exported to Singapore, Penang, Madras, and Ceylon. It is not sold at the pit's mouth, but is delivered at about 20 shillings, = $9.68, at Calcutta.¶

We have had some valuable private notes respecting this coal, but unfortunately they are mislaid. In 1847 an important project was brought forward, whereby the Burdwan coal district was intended to be traversed by railroad direct from Calcutta. By this arrangement the bituminous coal of Burdwan will henceforward be sold in Calcutta at a greatly reduced price.

Geological Age of the Burdwan Coal Deposit.—In the recent memoir of Count Strzelecki on the Geology of New South Wales and Van Diemen's Land, a comparison is instituted between the fossil plants of the coal formations there and those collected in the Burdwan coal-field, and described by Professor Royle. A remarkable analogy of form of some species, and the actual identity of others, was observed. At the same time, an interesting fact was established—that there existed few, if any, analogous forms, in the

* Asiatic Researches, 1833, Vol. XVIII. Articles by Messrs. Jones, Calder, and Voysey.
† Asiatic Researches, Vol. XVI. p. 397. ‡ Martin's Colonial Statistics, p. 283.
§ Edinburgh Philosophical Journal, 1832, p. 347. ‖ Mining Review, 1840, p. 102.
¶ McCulloch.

species now known in the coal-fields under consideration, with those of the European coal basins. There are here no traces of the genera so abundant in the latter, such as *Lepidodendron, Sigillaria, Stigmaria,* or *Coniferæ;* and, consequently, the author was led to infer that the flora of the southern hemisphere was perfectly distinct from the northern, at the carboniferous period.* See also New South Wales.

Dr. Falconer confirms these facts, as to the unconformability of the coal plants of the Burdwan coal-field with those of Europe—inasmuch as the former contains neither dicotyledonous nor coniferous wood. It is probable, he thinks, that it may be older than any of the English coal formations.†

Chittagong District, east of Calcutta.—We have no other information than the general report of the existence of coal here.

The latest observations tend to point out the continuity, with probably some occasional interruptions, of the Burdwan district, westward, for 250 miles, to Palamow; thence in a south-west direction for 420 miles more, through the district of Sohajepore and Jubulpore, to the neighbourhood of Hosingabad, on the Nerbudda river, on the left or south bank of the river.

From Burdwan the range extends northward, for 150 miles, to Rajmahal. Throughout the extensive range thus indicated, a number of beds of coal, of variable thickness and value, have been recognized.

The Burdwan district is traversed by two rivers, the Damooda and the Adjü. The coal is worked at thirteen localities, and comprises six small seams, besides one of seven feet and one of nine feet. The deepest shaft is 190 feet, and the actual transit to Calcutta is about 200 miles.

On the Adjü river the coal-field has been worked in more than one spot. It is of the same character as that of Burdwan. Veins six to thirteen and a half feet thick.

The *Rajamahal* coal-field is considered as the northern extension of the Burdwan region, but has not yet been worked. It approaches within about 200 miles of the coal district of the Garo hills, from which it is separated by the alluvial and tertiary valley of the Ganges.

At *Palamow,* which is now thought to be a westerly extension of the Burdwan district, coal has been worked in four places. It comprises several beds of workable size; but much of it is stated to be heavy and of inferior quality—being associated with a good deal of iron, while some of it appears to be anthracite. The same formation stretches northward, nearly to the Sone river, at about 100 miles from its confluence with the Ganges, a little above Patna.

To the south of Palamow, in the district of *Ramghur,* and Province of Bahar, coal occurs in the hilly region, and has been obtained in two or three places. This coal is said to be of good quality, and of considerable thickness. It is either a detached basin, or may possibly be a prolongation of the carboniferous formations of the Damuda or of Palamow. At present it appears that there is very little mining enterprise existing among the inhabitants.

At fifty miles westward of Palamow, at *Singrowli,* thin beds of coal are found in several places. Further to the south-west some fine coal occurs at *Sirgoojah,* but is not used at present. Between the Singrowli coal and Jubbulpore, excellent coal abounds.

* Physical description of New South Wales and Van Diemen's Land, by P. E. de Strzecki.

† Athenæum, October, 1846.

EASTERN BENGAL, DISTRICT OF SYLHET, DIVISION OF DACCA.

Sylhet Tertiary Coal Formation.—This has been denominated the North-east coal-field, while speaking of the Burdwan or north-west district, adverted to by Mr. Jones, Mr. Calder, and others, in the Asiatic Researches, 1816 to 1829.

Previous to the first named year, some operations were carried on by Mr. Stark, in the Sylhet coal, in 1815, which continued for above two years, when the experiment was abandoned.*

This coal, it is asserted, has been found far superior to the Burdwan coal; but certain local difficulties contribute to prevent its being extensively used.† Mr. Jones was under the impression that this coal was similar to that of Burdwan, and he conceived that the formation extended beneath the plain of the Ganges, so as to connect the two deposits. Mr. Jones traced the Sylhet tertiary coal eastward along the Garo hills, to Cachar, Sylhet, and into Manipur. All subsequent investigation seems to point out this formation as a tertiary coal, while that of Burdwan is apparently a true coal, occupying a basin. The Sylhet lignite has been shown to form part of a continuous band, for certainly not less than a thousand miles, parallel to the southern base of the Himalayan range.‡

Older Coal Formation.—In 1828, Mr. Herbert traversed the region in question, in a northern direction, from Pandua and Chuttak to the plain of Assam, and communicated the details and a section of his route.§ From the summit of the Pandua hills, northward to Suranim, the geological character of the elevated country is that of a coal region, five thousand feet above the level of the sea, where the coal is seen cropping out of the ground, in a region abounding in iron furnaces. Blue slate, to the height of 5942 feet, succeeded by red micaceous slate, constitutes the country northward, for the greater part of the area of the Pandua hills. From thence, crossing to the Brahmaputra river, is a primitive region. The coal formation above mentioned, is nearly horizontal; is many hundred feet thick, and rests upon limestone.

We are led to conceive, therefore, that this elevated coal formation, belongs to the true carboniferous age, and that it is a continuation of the coal measures, observed at several points, further to the north-west by Lieutenant Wilcox, which are accompanied by conglomerates, and by sandstones containing salt springs.

The more recent details, collected by Professor Ansted, tend to confirm this. He describes this coal district as commencing on the flanks of the Garo mountains, near the Brahmaputra and on the banks of that vast river, extending in a north-eastern direction nearly four hundred miles. True carboniferous rocks occur on both sides of the Garo mountains, commencing near Jumalpore, and extending through Upper and Lower Assam. This series may probably correspond with the coal measures of Burdwan.

In the same district, on the south flank of the Garo mountain, eleven beds of coal, having a total thickness of eighty-five feet, have been proved. This coal is of excellent quality, and belongs to the true carboniferous period.|| The most remarkable beds occur at Cherra Ponji, where the beds

* Bombay Times, 1840.
† East India Magazine.
‡ Asiatic Researches, Vol. XVIII. p. 169.
§ Ibid. Vol. XVII. p. 500.
|| Athenæum, October, 1846.

are sometimes nearly thirty feet thick. They have been known for more than ten years, but have not been worked.*

The analysis of the Cherra Ponjee coal is,	Carbon,	41	specific gravity,
	Bitumen, &c.	36	1.447
	White ashes,	23	
		100	

The strata are nearly horizontal. The coal is of the slaty kind.†

BHOTAN.

The Tístá river, descending from the Bhotan mountains, enters Northern Bengal at the foot of the lower range of Bhotan hills. These hills, as cut through by the Tístá, and as described by Mr. Scott, consist of sandstone containing much mica, and in fact would be correctly termed *granitic* or *granitoid sandstone*, being made up of the detritus of quartz, feldspar and micà. In the slaty varieties of these and some shaly clay-beds, are brown coal and bituminized wood.

Corresponding strata are seen in another pass of the Súbúk river, described by Messrs. Colebrooke and Scott.‡

NOHTHERN BENGAL.

Sub-Himalayan range—eastern prolongation of the Sewalik Hills.

Tertiary coal formation.—On the rivers Tista or Teesta, and Súbúk, which descend from the Bhotan mountains and traverse Northern Bengal, Mr. Scott, in 1822, discovered coal, in inclined sandstones and bituminous shale. These strata appear to form the lower range of hills which constitute the first steppe from the plains of Hindostan, ascending towards the mountains of Bhotan, and towards the loftier granitic peaks of the Himalaya.§

In 1837, a scientific expedition, under Dr. Wallich, traversed this parallel, and observed coal seams, horizontally reposing upon the sandstone, to the depth of twenty or thirty feet, along a space of fifteen or eighteen miles.

The strike or direction of the stratified range is stated by Mr. Scott to be north 50° to 60° east; in which respect it corresponds with the secondary carboniferous range east of the Brahmaputra. Even the gneiss is observed to take the same direction.

UPPER OR NORTHERN HINDOSTAN.

Province of Delhi, above Hurdwar, towards the Himalayan mountains, and the sources of the Ganges, a coal-field has been ascertained. Its specific gravity is 1.368.

Analysis,	Carbon,	50.00	100 parts.
	Volatile matter,	35.40	
	Ferruginous ashes,	14.60	

KINGDOM OF NEPAUL—SEWALEK OR SIVÁLIK HILLS.

In the lowest range of the mountains, westward from the Karda Valley, about four miles from the point where the river Choura Pani, opens into the

* Ansted's Report.
† Martin's Colonial Statistics, p. 367.
‡ Mr. Colebrooke, and Mr. Scott, in Trans. Geol. Soc. of London, new series, Vol. I. p. 138.
§ Trans. Geol Soc. of London, Vol. I. 1822.

plains, are seen thin seams of coal, alternating with indurated clay-beds, and white micaceous sandstone. Lieutenant Cautley, who mentions the circumstance, seems disposed to think that they were lignite beds, but he did not succeed in finding any fossil remains there, to determine the question. That it is tertiary, or of the same age as the lignites of the Sewalik Hills, there can now be little doubt. The specific gravity of this coal is 1.340. It breaks into rhomboidal fragments; is sulphurous, and leaves a red ash.

To this locality Lieutenant Cautley adds three others, along the range in the passes entering from the great plain, eastward of the Jumna river.*

Captain Herbert states, that the usual coal strata of this range,—which he traced from Sylhet on the east to Lahore on the west, being twenty-three degrees of longitude,—comprise micaceous sandstones, argillaceous beds, and conglomerates derived from the primary rocks. In colour, this coal is of the most perfect black; sometimes resembling the conchoidal brown coal, (except in colour) of Werner; sometimes like jet, and again like Cannel coal. Of course, it is bituminous; and so far approaches the most perfect coal, that Captain Herbert found the proportion of volatile matter it contained was no less than fifty-four per cent.†

A memoir of more recent date than the foregoing, by Captain Cautley, contains a description of certain beds of tertiary lignites, between the Jumna and the Ganges, and also to the eastward of the Ganges, ranging parallel with the Himalay mountains, for upwards of fifteen hundred miles. This lignite when it appears among beds of marl, is chiefly in the form of black dust; leaving, on its removal, indistinct vegetable impressions. When in sand, it is seen either in long flattened masses, or in transverse sections of trunks of trees; which show, by their elliptical form, effects of vertical pressure. Fossil wood, apparently dicotyledonous, abounds in sandstone. With these are the remains of tortoises.

In 1817, Dr. Voysey pronounced this to be the brown coal of Werner. Its specific gravity is 1.498.

The belt of undoubted tertiary strata, highly inclined, occurring next above the plain of Nepaul, appears to contain lignite more resembling fossil trees, in irregular deposits, than the regular horizontal coal seams which occur more inland at so much higher elevation. Similar features characterize the base and summits of the Caribari Hills, near Robagiri, east of the Brahmaputra. The former contains simply tertiary bituminized wood; the latter abounds in regular coal seams, which are extensively employed in the adjacent iron works, more than five thousand feet above the sea, near Saruram.

TERRITORY OF ASSAM, CEDED TO THE BRITISH BY THE BIRMESE.

Assam.—Eastward of Rangpoor, on the Brahmaputra river, (27° north latitude, 95° longitude,) is a range of sandstone in or near which coal is worked, and it was reported by Lieut. Wilcox, in 1824, to occur near Borhath. This sandstone region produces salt; which led the author to suppose it might be the new red sandstone, like the country bordering the Jumna river.

The same gentleman visited a bed of coal which crosses the Bori Dihing river near where it leaves the Noa Dihing, on the same parallel east of the Brahmaputra river, and where the jungles are full of the odour of petroleum. Beds of white mud are of frequent occurrence through this region, resorted

* Asiatic Researches, Vol. XVI. p. 390, in 1825. † Ibid., p. 402.

to greatly by cattle and wild beasts of all kinds, which eagerly devour this substance; probably from its saline properties. Petroleum floats on the edges of these mud springs, but it is not put to any use by the *Singfos;* neither is the coal.

Similar phenomena were noticed by Lieut. Wilcox in ascending the Noa Dihing, at about 96½ degrees longitude, and 27 degrees 20 minutes north latitude, showing the continuity of the range to the north-east, and the prevalence of sandstone and conglomerate formations in this country.*

Still higher up towards the sources of the Dihing, amidst similar geological phenomena, thin strata of coal, alternating with blue clay in the sandstone, were observed by the exploring party.

This great range of carboniferous sandstones appears to continue southwestwardly to the coal region of the Pandua hills, and the Sylhet district; there maintaining an elevation of five to six thousand feet.

In the absence of more direct testimony, we are led to the conclusion that this is an older series than the decidedly tertiary formation containing brown coal, at the *base* of the Caribari cliffs, described by Messrs. Colebrooke and Scott, and by them stated to occur at not more than twenty to one hundred and fifty feet above the level of the sea.†

The Assam coal districts extend, according to Professor Ansted's paper, about 350 miles, chiefly along the south side of the Brahmaputra.

In the upper district, six coal seams are enumerated, and three in the lower district. The coal of the upper area is associated with abundance of clay iron-stone. That of the Lower Assam is designated as lignite by Lieut. Vetch.

About eighty miles above *Biskenath*, other beds, six feet thick, have been worked for the sake of trying the economic value of the coal. The commander of one of the Assam Company's steamers describes it as the best coal he ever used, and far superior to any in Calcutta.

COAL OF THE KOSYA, COSSYAH, KASIA, OR KOSIAH HILLS.

Specific gravity, 1.275. Remarkable for the small amount of ashes.

Carbon,	60.70
Volatile matter,	38.50
Earthy impurities,	.80
	100.00‡

At the height of 1,500 feet, the first stage of these mountains, is a bed of tertiary marine shells, of which twenty-five species were identified by Mr. McClelland with those of the Paris basin. Lignites occur on the summits of this system of hills.§

COALS ADAPTED FOR STEAM NAVIGATION IN HINDOSTAN.

It has, doubtless, been perceived from the preceding details, that at present there is no positive certainty of the existence of a body of coals, of the first class, adapted for the purpose of steam navigation on these seas and rivers, and situated so as to be conveniently accessible for transportation.

The employment of the best description of coals, brought at an enormous

* Asiatic Researches, Vol. XVI. and XVII.
† Geological Transactions, Vol. I. New Series, 1822.
‡ Colonial Statistics, Martin, p. 367.
§ Bulletin de la Société Geologique de France, Tome XI. p. 269.

cost from Europe, can never be generally adopted here, and must be restricted to the purposes of the government alone. There is, moreover, a very great waste attendant on the transportation of coal to such remote points, and a depreciation of its quality by reducing a portion of it to the state of fine coal and dust.

For instance, it appears that about five thousand tons of English coal, at a freightage of about £2 per ton, are annually imported into Bombay, which coal is almost exclusively used by the company's steamers; though it is proved that, on account of defective arrangements, scarcely more than two-thirds are effectual in raising steam. The same remark has been made with respect to the English and Welsh coals delivered at Calcutta, where there has been generally a great accumulation of small refuse, for which no use, unless in burning lime, has been found.

The number of steam-engines now in operation in India is far greater than has been imagined: and therefore the supply of a suitable description of fuel is of no slight importance. A statement has been published, in India, wherein it is shown, that in the presidency of Bengal alone, in 1845, there were, in active employment, no fewer than 151 steam-engines of nearly 6000 horse power. The first engine ever set to work in this presidency was no farther back than the year 1820.*

NERBUDDA DISTRICT, LOWER PROVINCE OF CENTRAL INDIA.

Hosingabad Coal.—Experiments were made in a steamer, and the results compared with good Scotch coal, to the advantage of the former. This Indian coal had been brought upon camels, and consequently was much broken. The rate of steaming performed was upwards of ten miles an hour.†

BENGAL.—BOMBAY.

Economical application of the dust and refuse of the Coal imported from Europe.—A contributor of a valuable summary of Indian intelligence in the *Bombay Times*, October, 1840, shows that after numerous trials and many failures, the use of small waste coal was at length successfully practised at Calcutta.

The editor of the *Bombay Times* adds, "It is not generally known, that out of the whole of the coal imported at Bombay for the use of the Company's steamers, at the rate of about 20 rupees,=£2 per ton, not more than one half ever reaches the furnace fire of the engine. That portion, therefore, which does so, costs 40 rupees,=£4,=$19.36 per ton; the other half being ground to dust, fallen to pieces, or otherwise rendered unserviceable. There is at this moment in Bombay, some 1500 tons of coal dust, which has cost the Company about £3,000 sterling, and is of no earthly use, so far as is known, of which the marine store-keeper would be very glad to be relieved."‡

Prepared Fuel.—The editor suggests the adaptation of this coal dust as a fuel for various useful purposes, such as the burning in limekilns, brick-kilns, or tile-works; and saving the expensive firewood and other fuel employed by the natives. A thousand or two tons of coal dust, which was probably the annual amount wasted, if properly prepared, as in the manner of South Wales, of China, of Holland, and even in Calcutta, could not fail to benefit the community and cheapen production.

* Mining Journal from the Indian News, January 31, 1846. † Bombay Times, 1839.
‡ Mining Journal, Vol. X. p. 406.

COMPARATIVE VALUE OF COAL AND WOOD FOR FUEL.

Burdwan Coal, its adaptation to Steam Navigation.—There are four iron steamboats, drawing not more than thirty inches, employed in the navigation of the Ganges; and which use the Burdwan coal only. They consume about ten lbs. of this coal per horse power; and carry about four hundred and fifty maunds. The contractors have their coal in depôts on shore, and send it in boats to the steamers when they cannot lay alongside the bank. This coal is taken *by weight*, and one hour is allowed for the delivery of one hundred maunds. Wooden steamboats would be very inefficient upon the Indian rivers.*

A series of experiments were entered into by Captain Johnson, R. N., to determine the relative values of the best wood, and of coal, in the steamers on the Ganges. The result was, of course, in favour of the latter fuel. It required 15½ maunds of wood to produce the same quantity of steam as 9½ maunds of mineral fuel: but, owing to the weakness of the steam, provided by the consumption of wood, to perform the same distance, one-sixth more of time was occupied; a detention most injurious to the interests of internal steam navigation.†

Several experiments with the *Indus* steamer were made by Lieutenant Wood, Indian Navy, to ascertain the relative capability of wood and coal fuel. A variety of the most valuable kinds of wood were tried. With the very best description of wood, the furnaces were replenished once in seven minutes: with coal, not of good quality, every fifteen minutes. This gentleman ascertained that coal has an advantage over wood fuel, in something more than the proportion of two to one: and when the superior performance of machinery driven by coal was taken into account, it appeared doubtful which was the more economical plan to navigate the Indus, with coal brought from England, or with the jungle now growing on the banks of that river.‡ The question, which in 1835 was simply one of expense, has been since set at rest by the satisfactory discovery of abundance of excellent coal upon the very banks of the Indus itself.

A great part of the steam navy of the East India Company consists of iron vessels, twenty-five of which were not long since in use in India, and the number is increasing. Several of them are well known from the conspicuous part which those vessels performed in the war with China.

The first cost of iron vessels is somewhat less than that of timber-built vessels; they possess greater durability; and after years of constant employment, are as sound and as clean as when first built.§

A statement has been published, showing the number and tonnage of steam vessels in service and building belonging to a single company in India—"the Peninsula and Oriental Steam Navigation Company;" amounting to twenty-seven steam ships, of an aggregate of 28,300 tons, and 9,910 horse power; a fleet, it has been remarked, which is far superior to the Royal Steam Navy of the largest maritime power of Continental Europe.

* Remarks on the Iron Steamboats of the Ganges, by their Comptroller, Lieutenant Johnson, R. N.

† Report of Captain Johnson on the relative value of wood and coal, on the Ganges.

‡ Report on the river Indus, by Lieutenant Wood, Indian Navy.

§ Porter's Progress of the Nation, Vol. III. 1843.

The following details are partly founded on Mr. Ansted's pamphlet on the coal-fields of India, and partly from a variety of other sources, as previously mentioned.

Province.	District.	Beds or Seams.	Quality and Species.	Analysis. Carbon.	Volatile matter.	Earthy matter.
	Cuttack,	No details.				
Bengal,	Burdwan,	6 Seams, 9 feet, 7 feet, and below,	Good coal,	60	36	4
	Adju River,	6 to 13½ feet,	like the Burdwan coal,			
	Rajamahal,	not yet worked,	Same,			
Lower Assam,	Kurribari,	not traced,	Brown coal,	40.6	50	9.4
				25.4	70	4.6
Sylhet,	Garo hills,	Byrung Ponji,	Excellent coal,	65.4	31	1.5
	Cherra Ponjee,	Several: 2 to 28 feet,	Slaty coal,	41.0	36	23.0
Upper Assam,	Namsony,	6 feet.	Very good,			
	Suffry,	up to 12 yards,				
	Boorhath,	6 to 8 feet,	Coking coal,	52.7	45	2.3
	Teypore,	2 to 9 feet,	Superior,	46.2	48	5.8
	Kosiah Hills,	undescribed,	Very few ashes,	60.70	38.50	0.80
Central distr's of Bengal, Bahar,	Palamow,	Several beds to feet,	Slaty coal,	50.0	44	6
			Slaty crop,	58	32	10
			do.	63	25	12
Bahar,	Ramghur,	Considerable thick'ss,	Good quality,	53	31	16
				61	27	12
	Ruttenpore,	Immense thickness,				
	Surgoojah,		Fine coal,			
	Singrawli,	Thin beds,	Middling,	32.2	54	13.6
	Nerbudda,	20 to 40 feet,	Best in India,			
	Shawpore,	2 to 6 feet,				
	Jubbulpore,	undescribed,	Excellent,	47.1	50	[illegible]
Tinasserim,	Mergue,	About 6 feet,	Coking,	40	55	5
Aracan,	Ramree,	Thin seams,	Coking coal,	49	36	15
	Cheduba,	Thin seams,	Coking coal,	41.2	46.8	12
Gwzerat,	Cutch,	Many thin seams,				
Punjab,	Jummoo,	Anthracite,	No details.			
Lahore,	both banks of the Indus.	Coal seams,				
	Attoch,	Coal-field,				
Delhi,	Hurdwar,	Coal-field,		50	35.40	14.60
Nepaul,	Sewalik,	Thin seams,	Tertiary cannel coal,		54.00	

TURKESTAN, OR INDEPENDENT TARTARY,

(CENTRAL ASIA.)

GREAT BOKHARA, OR BUCHARIA.

Kingdom of Balkh, or Bactria.—Its chief city, of the same name, "the mother of cities," was formerly the residence of the kings of *Bactria*, and the rival of Nineveh and Babylon.

At Kobal, on the north bank of the Oxus, coal was procured by Dr. Lord, in 1842.

Coal is found in many other parts of Tartary.

Brown coal also exists in the southern and western portions of the country.

KHOKAN, OR FERGHANA.

This is an independent Khanat of Turkestan, north of Bokhara.

This mountainous region contains, among other minerals, coal, the use of which has been long known in Khokan, since Abulfeda speaks of "stones that flame and burn," being found there. This important mineral may, at no very distant period, become a powerful auxiliary in civilizing this, at present, semi-barbarous region.*

NORTHERN HINDOOSTAN.

Province of Cashmere.—In the dominion of the Maharajah of the Punjab; extending northward along the Indus, to the central chain of the Himalaya and Hindoo Koosh, or Indian Caucasus.

We are not aware of any coal in this province.

At various places jets of inflammable gas escape from the ground, and spontaneously ignite. Like similar springs at Baku, on the Caspian, they are considered peculiarly holy, and temples are built over them.

These springs are only adverted to here, for the sake of showing the probable continuation of the vast zone or range of tertiary lignites with petroleum, which may be traced along the entire extent of the Himalaya chain; and which may probably be hereafter traced with few important intervals from Europe on the west, to the Birman Empire on the east.

BIRMAN EMPIRE.

Province of Ava.—Banks of the Irawadi River.—In numerous places, between Prome and Ava,—that is, between N. lat. 19° and 22°, Mr. Crawford found beds of brown coal, and wells of petroleum; co-extensive with a tertiary clay formation.

* McCulloch, Vol. II.

These wells have been sunk to the depth of 207 feet.*

The "mountain coal" of Ava yields a coke of middling quality, but of very little density. Probably, this is brown coal also.

Silicified and calcareous wood of Ava.—Fossil trees were traced by Mr. Crawford, five hundred miles along the course of the Irawadi river. In accordance with Dr. Buckland's views, at the period of his describing these remains, they were pronounced "tertiary." In common with the numerous bones of mammalia, they certainly repose upon tertiary rocks, resembling the *calcaire grossier*, the London clay, and the plastic clay beds. The wood mostly consists of portions of large trees, both monocotyledonous and dicotyledonous. It was observed by Dr. Buckland, that a singular circumstance attended these vegetable fossils; for that all the monocotyledonous plants were agatised, while most of the dicotyledonous remains were in the state of carbonate of lime.

Amber exists in Ava: described by Sir David Brewster, at the meeting of the British Association, in 1835.

PROVINCE OF PEGU.—RANGOON OR RAINANGHONG.

Naphtha Wells.—At about eighty hours' journey north-east of Pegu are one hundred and eighty naphtha wells; three hundred and forty others are situated about four or five miles to the north-east. This substance is burned in lamps, and used for painting the timbers of houses and the bottoms of boats and ships, which it protects from rot, and the attacks of worms. The gross amount of oil annually obtained from the five hundred and twenty registered wells, is about a hundred thousand tons, or four hundred and twenty thousand hogsheads. It gives rise to an important business,† and amounts in value to £170,290 sterling.‡

Above Prome, petroleum is obtained in large quantities. The wells are about two miles from the Irawadi; produce each a daily average of one hundred and fifty gallons, which sells on the spot for about 1*s.* and 8*d.* per cwt. The gross annual produce is about eighty millions of pounds, and might be greatly increased. Coal is said to have been met with in various spots—probably wood coal.§

Mr. Coxe estimates the produce of the naphtha springs of Rangoon at 92,781 tons per annum.

Tertiary Coal.—The hill in which the five hundred and twenty petroleum pits occur, contains much coal, at Yananghoung or Rainanghong, on the banks of the Irawadi or Erawaddy river. The naphtha springs issue from a pale blue clay, saturated with the oil, and resting upon roofing slate.

Under this slate is the coal before mentioned, containing much pyrites.

Each spring yields, annually, 173 casks, of 950 pounds each.‖

* Mr. Crawford and Dr. Buckland, in Trans. Geol. Society of London, 1828, 2d series, Vol. II.

† Article in Mining Journal, March 11, 1837.

‡ Allan's Manual of Mineralogy.

§ McCulloch's Birman Empire.

‖ Dictionary of Commerce, McCulloch; also Ure's Dictionary of Arts and Manufactures, p. 885.

BIRMAH.

NORTHERN CHINESE PROVINCES OF BIRMAH.

Amber is worked here by the Chinese, and doubtless wood coal. Amber is found in immense quantities in the Valley of Hukong, an extensive plain, fifty miles long, and from fifteen to forty-five miles wide, apparently the bed of an ancient lake. It is also celebrated for the great amount of gold and silver which is annually procured there.

CASSAY, KATHEE, OR MUNNEEPOOR (MANIPUR).

Coal, thought to resemble the Sylhet coal or brown coal, is said to occur in Munneepoor, to which place Mr. Jones states he had traced it from Sylhet.*

FARTHER INDIA.

BRITISH PROVINCES OF TENASSERIM.

Mergui Island, Bay of Bengal, in about 12° north latitude, near the *Isthmus of Krau*, and *Peninsula of Malay*.

We have seen a report of Dr. Hutchinson on the coal-fields lately discovered on this island. It is also mentioned in the Mining Journal, Vol. XI., p. 15 and 23.

Lieut. Hutchinson was employed in 1840, in sinking shafts, and making tram roads, at the coal mines.

By advices, received in April 1841, it appears that a large vessel, the Clarendon, was employed to convey the coal from Mergui to Sincapore, and that it was fully expected to answer.

The extensive coal beds here have acquired an additional value in consequence of the discovery of a rich bed of iron ore in its immediate neighbourhood. This ore is found on the surface, and requires no expense of mining.†

WEST COAST OF TENASSERIM.

Professor Royle states that, in addition to their abundant products of tin and iron, the British provinces of Tenasserim contain coal.‡

This district has become important, from its near vicinity to British India. The coal is probably a lignite.

Four localities are known here. One of the beds is favourably spoken of, under the name of Cannel coal.§

* Mr. Jones in Asiatic Researches.
† Mining Journal, from the Maulmein Chronicle, Jan. 9, 1841.
‡ Proceedings of Geological Society of London, Vol. IV. No. 94.
§ Ansted's Report, 1846.

PROVINCE OF ARACAN, FORMERLY PART OF THE BIRMAN EMPIRE.

Bituminous Coal.—The specific gravity of this coal is 1.308. Carbon, 33.00; Volatile matter, 66.40; Ashes, 60; total, 100.

Coal has been worked at four localities; one of which promises to become valuable. Another has been the subject of a report from Mr. Princeps, who states it as an admirable coal for gas. The whole is, however, of the tertiary period. Eleven beds are now known; they are thin, and have a nearly vertical position.

RAMREE ISLAND.

North latitude 19°, on the Birman coast. A large quantity of good coal was brought by the Amherst steamer, in 1841, from this island. It was worked out of two mines there, and other coal beds have been traced.† Perhaps brown coal.

MALAY.

On the 26th of May, 1847, was read to the Geological Society of London, "a notice of the discovery of coal on one of the islands near the west coast of the Malay Peninsula," by J. R. Logan, Esq.

The coal has been found by a Penang Siamese, on the southern coast of the Island Junk, Ceylon, north latitude 8°, well known for its tin. It is described as of a black or brownish-black colour; burning with a clear flame, and is highly bituminous. One seam is three feet thick. The discoverer offers to import it into Penang at 12*s.* 6*d.* per ton. It occurs near the bank of a river, at 200 or 300 feet only from its mouth.

MALAYAN PENINSULA.

THE PERAK COUNTRY,

Commencing about 4° south latitude. Capt. Lowe states that this region, so rich in gold and tin, iron and antimony, according to reports of the natives,

* Colonial Statistics of the British Empire, Martin, p. 367.

† India Review. It is scarcely necessary to observe, that in the majority of the localities of supposed coal last cited, we have no authority for their geological age; but we have reason to think they chiefly, if not all, belong to the lignite class.

contains coal in the interior. The difficulty of making researches in this wild, yet beautiful country, has hitherto prevented the geologist and the mineralogist from examining it with the care it deserves. Were European scientific men permitted to explore this rich and imperfectly known mineral region, we might expect to derive interesting results from their labours. The jealousy shown by the Siamese has hither prevented almost all observation.*

NICOBAR ISLANDS,

Formerly occupied by the Danes, but long abandoned on account of the unhealthiness of the climate. In 1846, it was visited by a Danish ship of war, engaged in a scientific and exploring expedition. A party of scientific gentlemen, naturalists, mineralogists, geologists, &c., were landed and remained here several weeks, exploring these long neglected islands. Among other matters of interest, the geologists were successful in discovering beds of coal.

SUMATRA,

In the Eastern Archipelago, situated beneath the equator. Brown coal and bituminous wood is met with, and probably older or true coal.†

Mr. Marsden, in his History of Sumatra, merely observes, that "coal is mostly washed down by the floods, and is collected in several parts, [between the third and fourth degrees of south latitude,] particularly at Kattaun, Ayer-ram-mi, and Bencoolen. It is light and not very good; but I am informed this is the case with all coal found near the surface of the earth; and as the veins are observed to run in an inclined direction, until the pits have some depth, the fossil must be of an indifferent quality."‡

Naphtha is one of the mineral products of Sumatra.

BORNEO,

Called *Bruni* by the natives. A coal formation, probably a superior description of brown coal, is now known to exist on *Pulo Cheomin*, or *Cheremin*, or *Mirror Island*, at the embouchure of the Borneo river. This coal extends along the coast, and is covered at high water, and also takes a direction inland. We are assured, in fact, that the coast presents *a naked surface of coal.*

Mountains of coal, or rather containing coal, are described by intelligent natives, [Nakhodas,] who say that hundreds of ships might be laden with it. This information is regarded as of considerable importance, in respect to its facilitating the steam navigation of the China seas.

A communication from Mr. Jay, on the geology of Borneo proper, has appeared in the Geological Transactions of London.

In April, 1845, an English war steamer visited Borneo, with a special agent of the Queen of England, who had purchased the exclusive right to all the coal within the dominions of the Sultan. Immense beds of coal are known to exist in this part of the island; which, in course of time, must render incalculable benefit to commerce, when steam, already an important auxiliary, becomes a chief agent in the commerce of the world.§

Batal Apig, on the south of Borneo, an extensive bed of coal discovered in 1846.

* Asiatic Researches, Vol. XVIII. † Allan's Mineralogy, p. 294.
‡ Marsden's History of Sumatra, 1811, p. 28.
§ Letter from a United States officer, dated "Coast of Borneo, April 9th, 1845."

Lignite is also found by the natives, imbedded in sandstone, in a deep ravine, not far from Borneo city. This bed of brown coal is more than six feet thick.*

ISLAND OF LABUAN,

Now one of the possessions of Great Britain. Bituminous coal was discovered here in 1846. On the adjoining and opposite coast of Borneo, extensive coal deposits were previously known to exist. These were under the control of Mr. Brooke, as rajah. Their advantages now promise to be superseded by another of greater magnitude, in the discovery of a large bed of coal on the island of Labuan. Our knowledge of this interesting fact is due to the investigations of Lieut. Heath, commander of the Wolf. The seam commences at a distance of 334 yards from the beach; and, what is of the utmost importance, it occurs in the vicinity of a bay where there is good anchorage and a sufficient depth of water to allow steamers, of moderate draught, to proceed close in shore. Much care was bestowed in ascertaining its direction, and it was observed at seven different places; the thickness being mostly twelve feet. In the trials made as to the combustion of this coal, it was estimated as about equal to Newcastle, as regards heat and flame, but its combustion was more rapid.†

EAST INDIA ISLANDS.

PHILLIPINE ISLANDS—LUCON OR LUZON, &c.

Captain Wilkes, commander of the American Exploring Expedition, in 1842, visited this Island, and at Manilla obtained some information respecting the existence of bituminous coal, on the northern peninsula. He states that, so far as the observations and information of the exploring party extended, the whole of the Phillipine Islands partake of a mixed geological character, consisting of granitic, secondary, and tertiary formations, among the mineral products of which coal is frequent. In some of the islands the coal beds form part of the cliffs along the shore, while iron, gold, lead, rock-salt and copper prevail in the mountains.

The coal, Captain Wilkes observes, is deemed of value. It has a strong resemblance to the bituminous coal of America; possesses a bright lustre, and appears free from all woody texture when fractured. It is found associated with sandstone, which contains many fossils.

Lignites in Tufa.—The country around Manilla is composed of tufa, which is employed as a common building material, and contains impressions of plants, with petrified woods of the recent species, including palms.‡

Java.—Coal is said to abound.

* Trans. Geol. Soc. of London, April, 1840. Also Proceedings, Vol. III. p. 291.
† Chambers' Edinburgh Journal, April 17, 1847.
‡ Narrative of the United States Exploring Expedition, Vol. V. p. 283, 1845.

SIBERIA.

OURAL OR URAL MOUNTAINS, EAST SIDE.

Lignites, with amber, were discovered, or rather were investigated here by M. Humboldt. These he decides to be older than the bones of the elephants enveloped in the adjacent auriferous sands.

Amber is also found in a lignite formation, at the embouchure of the Jerissey, in Siberia.

In the vicinity of the river Viliui, one of the principal western tributaries of the Lena, there are said to be mines of coal; an article which, as wood is hardly to be got so far to the northward, cannot fail to be useful when steam is introduced on the Lena.*

BARNAOUIL.

This town is the great depot of all the gold which is found in Siberia, east of the Ural. The forests in the vicinity are much despoiled of their timber, in consequence of the immense quantities of wood required for the furnaces. Eighty thousand cubic fathoms are annually burned at these works. Here are one hundred and fifteen smelting furnaces, twelve large open hearths, twelve refining furnaces, five furnaces for copper, and fourteen calcining ovens.

Two hundred and sixty thousand measures of coal, each containing twenty poods, and 400,000 poods more, are annually consumed at these works.†

TOBOLSK.

Although richly abounding with the precious metals, particularly along the *Altai Mountain range*, bordering upon China, coal does not appear to have been discovered. The want both of firewood and coal in this vast range, is a great impediment to the smelting of the metallic ores of southern Russia, and prevents the increase of the annual produce of the mines.

CHINA.

CHINESE EMPIRE—TCHINA, [*Malay*,] CHINE, [*Fr.*]

Coal-fields.—Mr. Williams, who is our latest authority [1848] estimates, with McCulloch, the eighteen provinces which form China Proper, at about 1,348,870 square miles, and with the entire provinces, at 2,000,000 square

* Overland Journey round the World, by Sir George Simpson, Phila., 1847, p. 142.
† Recollections of Russia, by C. H. Cotterell, London, 1842, p. 208.

miles. The census of the eighteen provinces, taken in 1812, shows that there were then 362,447,183 persons. The population is now above four hundred millions.

A Russian officer, in a sketch of the environs of Pekin [1840], states that the western mountain range contains coal in such abundance, that a space of half a league cannot be traversed without meeting with rich strata. But the art of mining is yet in its infancy among the Chinese; notwithstanding which, coal is at a moderate price in the capital. It is probable that coal was discovered in China long before it was known in the western world.*

About the middle of the thirteenth century, a noble Venetian, in his description of China, observes that "through the whole province of Cathay, certain black stones are dug out of the mountains, which, being put in the fire, burn like wood; and, when kindled, they continue burning a long time; in so much, that if they are lighted in the evening, the fire will keep alive during the whole night. Many use these stones, although they have plenty of wood, the consumption of fuel in stones being very great."†

But we have other evidence of the knowledge of this substance as far back as the eighth century. The missionaries inform us that coal is so abundant in every province of China, that there is perhaps no country of the world in which it is so common.‡ The provinces of the north, in particular, contain immense bodies of coal.

Father Semedo, two centuries ago, relates of the Chinese domestic establishments,—"In lieu of wood, they commonly employ a species of stones; not small, as in some of our provinces, but of considerable size. The mines from whence they draw this material, which burns so easily, [it is our coal,] are almost inexhaustible. In some places, as in Pekin, they know so well how to prepare it, that the fire is never extinguished, night or day."

Father Trigault says also,—"For fuel, the kingdom furnishes not only wood, charcoal, reeds and stubble, but they have a sort of bitumen, such as that which is mined in the Low Countries, principally in the bishopric of Liége. It is best and most abundant in the provinces of the north. It is drawn from the bowels of the earth, where, extending over a great space, its use is rendered universal; and by the moderation of its price, is shown to be so copious that it furnishes a combustible to the poorest person."§

Mr. Mitchell states that the mountains of the provinces Shansi and Chihli supply large quantities of coal, and that many boats find constant employment in bringing a coarse anthracite from Kaichan, in Liautung, to Tientsin. One locality of the coal in Liautung, is about Lat. 39° 10′ N., and Long. 121° 25′ E. "Several kinds, both anthracite and bituminous, are seen in the marts at the north; and coal-dust and refuse is mixed with a little moistened clay, at Pekin, and made into cakes for the fires of the poor. That which is brought to Canton is hard, and leaves a large proportion of ashes after combustion. During ignition, it throws off a suffocating sulphureous smoke, which prevents the natives from using it for cooking. It is employed in the manufacture of copperas."‖

The quays at Nankin are stored with the finest native coal. We have yet to ascertain whether this coal is derived from a central ridge in that wide

* Arnot's History of Edinburgh.

† Marcus Paulus, Venetus. Purchas's Pilgrim, Vol. III. p. 88.

‡ Narrative of the Route of the Dutch East India Company's Embassy in China, tome 2, p. 171, 3, 4.

§ Histoire Universelle de la Chine, p. 30; Le P. Semedo.

‖ The Middle Kingdom of the Chinese Empire, by S. W. Williams, 1848, Vol. I. p. 242.

country, or whether it be brought from the same source as supplies the city of Pekin.

At the mouth of the Pei-ho, the river that descends from Pekin into the gulf of Pe-tchee-lee, the coal used there was brought from the neighbourhood of Pekin. Mr. Abel observed that it contained very little bitumen, and resembled plumbago rather than coal, and evidently was anthracite.*

During the passage of Lord Amherst's embassy in the interior, between the Lake Po-yang-how and Canton, coal was frequently observed. Near this lake pits, like wells, had been sunk, to obtain that fuel, which had the characters of Bovey coal.† Coal was abundantly offered for sale in the different cities through which the embassy passed, and the boats were largely supplied with it.

In approaching Canton, near Chaou-Chou-foo, coal was observed stratified with slate, and in the vicinity of red sandstone; it contained sulphur.

South of Nankin, the coals seen in the towns on the *Yang-tse-kiang* river, resembled cannel coal; while that in the province of Pe-tche-lee, as we have before stated, was a species of graphite.

We have, therefore, evidence that, amongst other varieties, there exists tertiary or brown coal; bituminous coal of various kinds, cannel coal, and anthracite; all of which for ages have been in common use in this remarkable country, employed for every domestic purpose known to civilized nations, and in the manufacture of iron and other metals.

Whether the Chinese have adopted the principle of lighting their houses or towns with gas, artificially prepared from bituminous coal, we know not. But in this vast country it is certain that there are gaseous exhalations, or natural gas vents from the earth, as well as numerous others which have been artificially produced, and which have been burning for centuries, and are turned to economical account.‡

A contributor to the Edinburgh Philosophical Journal furnishes some details whereby we ascertain that if the Chinese are not manufacturers of gas, they are, nevertheless, gas employers and consumers, on a large scale; and have evidently been so, ages before the knowledge of its application was acquired by Europeans.

The process is the following. Beds of coal, though at a great depth, are frequently pierced by the borers for *salt water*, and from the wells thus made, the inflammable vapour springs up. It sometimes appears a jet of fire, from twenty to thirty feet high; and in the neighbourhood of Thsee-Lieon-Teing, the salt works were formerly heated and lighted, by means of these fountains of fire.

Bamboo pipes carry the gas from the spring to the place where it is intended to be consumed. These tubes are terminated by other tubes of pipe clay, to prevent their being burnt. A single well heats more than three hundred kettles. The fire, thus obtained, is said to be so exceedingly brisk, that the cauldrons are rendered useless in a few months. We presume this process refers to the boiling and evaporation of salt, in the pans or kettles, through the agency of the fire thus acquired from the ignition of the gas.

For the purpose of illumination, other bamboo tubes conduct the gas, intended for lighting the streets, and into the large apartments and kitchens.

* Abel's Journey in China, p. 71. † Ellis' Embassy, Vol. II. p. 107.
‡ History of Fossil Fuel, p. 406.

Thus, nature presents, in these positions, a complete establishment of gas light. As the whole of the gas cannot be consumed, the excess is conducted beyond the limits of the salt works, and there forms separate chimneys or columns of flame.*

We derive a corroboration of these and similar details from the work of M. G. Pauthier on China. "There exists," he states, "in China *wells or pits of fire,* [Ho-tsing,] which descend to considerable depths, yielding inflammable gas, which is economically employed in salt boiling.

"This phenomenon, which Aristotle says existed in Persia, in the caves where the ancient sovereigns caused their food to be cooked, is common in certain provinces of China, where it is employed very advantageously in economic uses. We are astonished, above all, at the means which the Chinese have acquired, to avail themselves of these immense mines of subterranean fire, or fossil fire, as they prefer to call it, of which a single spark reveals the existence. We find mention of them in the poetry of the celebrated *Tou fou,* the Chinese poet, who lived under the *Thang,* in the middle of the eighth century of the Christian era."† Father Semedo, mentioned them about two hundred years ago, in his *Histoire universelle de la Chine,* where he says, "As we have wells of water in Europe, so they have them of fire in China, for the services of the houses; for, having beneath them mines of sulphur, which are already lighted, they have only to make a small opening from whence issues heat enough to cook whatever they wish."‡

M. Imbert speaks also of *puits de feu* at Ou-tong-Kiao, near Kiating, in the department of the same name, in the province of Sse [or Szü-] tchouan [the four rivers,] at the foot of the high mountains belonging to the chains of Thibet, at 112° 11′ longitude, and 29° 33′ north latitude. We think that these details are too interesting not to be quoted here.

"There are," says he, "some ten thousand of these springs, or artificial brine pits, in a space about ten leagues long and four or five leagues broad. The Chinese effect the boring of these pits with time and extreme patience; yet with less expense than with us. They have not the art of working rocks by mining; yet all the pits are constructed in the rock. These pits are commonly from fifteen to eighteen hundred French feet deep,§ and are only five, or at the most, six inches in diameter. These little wells or tubes, are perpendicular, and as polished as glass. Sometimes, the entire depth is not continued in solid rock, but the workmen encounter beds of shale, coal, &c.; then the operation becomes more difficult, and sometimes fruitless; for as these substances do not offer a uniform resistance, it sometimes occurs that the shafts lose their perpendicularity; but these are rare cases. When the rock is favourable, they advance at the rate of two feet in the twenty-four hours. It requires at least three years to sink one pit." The mode of pumping up the water is extremely simple, yet laborious; being effected chiefly by manual labour. This water is very briny; giving, by evaporation, a fifth or more, and sometimes one-fourth, of salt.

The air which escapes from these pits is very inflammable. If a torch is presented to the mouth of the shaft, the gas ignites, with a great column of fire, from twenty to thirty feet in height, exploding with the rapidity of powder.‖ The writer goes on to detail the manner of its application to the

* Edinburgh Phil. Journal, 1839. † L'Univers. Chine, par M. G. Pauthier, p. 16.

‡ Semedo, Histoire de la Chine, p. 30.

§ The French foot is 1 foot 1.15 inch, English.

‖ The Chinese, both Pagan and Christian, have a great dread of this inflammable gas, believing it to be "le feu de l'infer;" literally, hell-fire.

evaporation of the salt water. But here the heat so obtained is insufficient for the entire purposes of the salt-works. The largest fire wells are those at Tsé-Lieou-Tsing, forty leagues from thence.

"It is therefore necessary, on account of there being so many salt wells, to have recourse to coal, in some quantity; and there are different kinds in the country. The coal beds have a thickness varying from one inch to five inches. The subterranean passage, which conducts to the interior of the mine, is sometimes so steep, as to require the aid of ladders of bamboo. The coal occurs in large pieces. Most of these mines contain much of the inflammable gas, previously spoken of, so that the workmen cannot light their lamps. The miners have to grope along almost in the dark; lighting themselves, feebly, with a mixture of sawdust and resin, which burns without flame, yet is not extinguished. In opening these little salt pits, they sometimes find, at several hundred feet depth, very thick coal beds; but they dare not work these great depositaries, because they do not know how to use gunpowder for such purpose, and they dread to find the water in such quantity as to render their works useless.

When they sink the salt shafts, having attained a thousand feet in depth, they commonly find a bituminous oil, [petroleum,] which burns in the water. They collect daily four or five jars of a hundred pounds each. This oil has a very powerful odour; and is used to light the area where the pits and coppers of salt are concentrated.

These coal mines and salt pits employ an immense population. There are individual proprietors who own as many as a hundred pits.

Tsé-lieon-tsing, situated in the mountains, in the province of Szütschuan, on the banks of a small river, also contains salt pits, bored in the same manner as at Ou-tong-kiao. In one valley are seen four pits which give a flame, to an amount truly frightful, but no water.* These pits, for the most part, have previously afforded salt water; which water, being drained, the proprietors, twelve years since, caused them to be sunk even to *three thousand feet and more* of depth, hoping to procure an abundant supply of water. All this was in vain: but there suddenly gushed forth an enormous column of air, which brought with it large dark particles. These did not resemble smoke, but the vapour of a glowing furnace. This air escaped with a roaring and frightful rumbling, which was heard at a great distance.

The orifices of the pits are surmounted by a wall of stones, six or seven feet high, for fear that, inadvertently, or through malice, some one might apply fire to the opening of the shafts. This misfortune happened in August last. As soon as the fire was applied to the surface of the well, it made a frightful explosion, and even something was felt approaching to an earthquake.

The flame, which was about two feet in height, leaped over the surface of the earth without burning any thing. Four men devoted themselves, and carried an enormous stone over the orifice of the pit. Immediately it was thrown up into the air; three of the men were scorched, the fourth

* M. Pauthier observes, in a note—"Supposing the provinces of China which contain these fire-wells, were placed at one of the poles of the earth, they would suffice, during the six months absence of the sun, to illuminate that area with these grand natural flambeaux; at least so far as the curvature of the earth would permit the luminous rays to strike the points on its surface. And if, by another induction, one could suppose all the columns of natural flame reunited in one point, placed in the atmosphere, or beyond, at a convenient distance, we should have there a luminous body which would not borrow its light from the sun, and which would console us for its absence."

escaped; neither water nor dirt would extinguish the fire. Finally, after fifteen days of stubborn work, a quantity of water was brought over the neighbouring mountain; a lake or dam was formed, and the water was suddenly let loose, which extinguished the fire. This was at an expense of about thirty thousand francs; a considerable sum in China."

The flame yielded by this gas produces scarcely any smoke, but a vapour highly bituminous, which could be smelt two leagues off. The flame is reddish, like that of coal; it is not attached or fixed to the orifice of the tube, like that of a lamp; but it hovers about two inches above the opening, and rises about two feet.*

These fire wells or springs are said very commonly to reach a depth of from 1,800 to 2,000 feet. One of these at Tse-lieon-tsing, above mentioned, was bored with the rod, in 1812, to the depth of 3,000 feet.†

One finds a singular parallel to this Chinese process of boiling, evaporating, and lighting, by means of the gas ascendiug from deep bores, where salt and coal are both pierced in the same shaft, in our own day, 1847, on the opposite side of the globe, in America.

At Kanawha, in Virginia, United States, gas, issuing from a depth of a thousand feet, forces up the salt water fifty feet above the surface, into the boilers. Then, being ignited, it is passed beneath the boilers, and the saline water is heated to the point necessary for crystallization. Thence, the gas is conveyed to the cisterns, where its heat alone accomplishes the evaporation. In this way, three hundred and fifty bushels of salt are made per day; with neither fuel, nor solar heat, but only that produced from the ascending gas.‡

In the United States, in the valley of the Ohio, petroleum springs occur in the saline wells, which discharge an irregular supply of petroleum, and of inflammable gases. The "burning spring," near the centre of the salines, on the Kanawha, is an interesting natural phenomenon of this description. It rises near the centre of an open square, given to the public by the liberality of Washington, who owned large tracts of land on the Kanawha, and considered that no parsimonious individual ought ever to appropriate it to his own private benefit.§

Since the foregoing passage was written, some further investigations in the salt works of Virginia, led to the discovery, in April, 1845, of the most remarkable supply of natural gas which is now existing.

The whole account is so interesting, that we are constrained to give the statement in full, as it is furnished by the local press.

NOTE. *Kanawha Salt Works.*—It has been known to the public for some two years, that several extensive salt furnaces in the Kanawha salt region, have been operated exclusively by gas. The gas forcing up the water from the depth of a thousand or fifteen hundred feet, and then being collected in a barrel, which serves as a gasometer, it is conveyed by a pipe to the furnace, furnishing all the heat necessary to carry on, at the same time, all the processes of the manufacture of salt to its completion, in an establishment capable of making a hundred barrels in a day—and at night brilliantly lighting up the whole works—thus saving the expense of a steam engine to pump up the water—all the fuel and lights. Last week, in deepening one of the wells, the auger struck a stream of gas, at the depth of one thousand feet, that in quantity and force, far surpasses any thing of

* Annales de l'Association de la propagation de la foi, Janvier, 1829.
† Humboldt, Asie Centrale, tome II. p. 521 and 525.
‡ American periodicals, 1844. § Silliman's American Journal, 1836.

the kind heretofore discovered here, or, perhaps in the world. The auger was pressed up with such force, as almost to overcome the exertions of the workmen to hold it down, while they could unscrew the detachments. The way being cleared, the gas having full play, sent a column of water one hundred feet, (and if tubed, would no doubt raise it to double that distance,) occasionally discharging stones from the size of a musket ball to that of a hen's egg, almost with the force of grape shot from a piece of ordnance. When we were there, all hands were engaged in active efforts to get down a plug to check the force of the gas, so as to enable them to insert the tube. They have, we learn, partially succeeded, and in a few days, both the gas and water will be turned to a good account. Serious apprehensions were justly entertained of the destruction of the furnaces, in the immediate neighbourhood, as well as of the residence of Mr. W. T., should this immense body of gas take fire, which, it was thought, might occur from a steamboat passing on the river, so extensively was it diffused in the atmosphere. A strong guard is kept up night and day to prevent such a catastrophe. On Saturday the third well from the one we are speaking of, took fire, and with the most active exertions, was not extinguished till considerable damage was done to the works.

That our readers may have some idea of the extent of nature's laboratory, or gas manufactory on the Kanawha, we will say, that gas enough issues from this single well to light all the cities in the United States, and we think we might safely throw in London, Paris, St. Petersburg, and a half dozen other cities of Europe.*

PEKIN.

The good missionaries, M. Collas and M. Cibot, stationed at Pekin, in 1775, have communicated some details respecting the ordinary uses of coal there, which are not without interest, even at the present day, and of which a short abstract may be not improperly introduced here.

M. Collas,† commences with the remark that the coal used in Pekin, may be compared with that of France, and perhaps with that of Liege.

Among the people of Pekin three principal kinds are in use.

1. That which is only employed by blacksmiths. This kind, it is asserted, burns only when the fire is animated by the blast of the bellows. It yields more flame than the other qualities, and in general, is more fierce, but is very subject to decrepitate (eclater) in the fire. The blacksmiths use it pounded in very minute particles.

The coal employed in culinary purposes is distinguished as two kinds. One variety which they call *ing-mei*, the other *joan-mei*.

Mei, in Chinese, designates the substance which we call coal [Charbon de Terre.]

Ing, implies hard, tough, and strong [*ergo* hard coal.]

Joan, means soft, feeble, in contradistinction. The merchants have also an intermediate quality, which they call *ong-mei*.

M. Collas had a small furnace or stove erected, in which he experimented upon the properties of the Chinese coals, particularly for the ordinary domestic purposes of warming his apartments and for the use of his laboratory.

2. The coals which are designated *ing-mei*, gave more flame than the

* Kanawha Republican newspaper, Virginia, April, 1845.

† Memoires concernant L'Histoire, les Sciences, &c., des Chinois, par les Missionnaires d e Pe-kin, Tome Onzieme, p. 334.

others; are less quickly consumed, and leave a residuum almost entirely of grey ashes.

The best of these are commonly hard to break, of a fine grain, a deep black colour, soiling the hands less than the others, and seldom have brilliant particles. Among other kinds sold as *ing-mei*, are some which are coarsely granular, full of brilliant points, are easily broken, and make a very good fire, leaving a reddish ash.

Another kind of *mei*, crackles or decrepitates as soon as it is placed upon the fire, and falls down almost entirely, in scales, which close the passage of the air, and stifle the fire.

3. The coal called *Joan-mei*. It scarcely gives out any flame; its heat is sensibly less than the *ing-mei*, and burns or consumes more quickly, and breaks with greater facility. In general it is of a deeper black colour than the other sorts of *mei*.

It is commonly this description of coal which they mix with coal ashes, and a fourth part of yellow earth or clay, to form an artificial and economical fuel. Of this material they make up in square moulds or frames, the lumps, which, in the form of bricks, are sold in the shops of Pekin.

From this admixture of ingredients there frequently accumulates in the stoves, a vitrified matter or scoria. This substance, [clinker] is always great in proportion to the amount of earthy matter added. It is never observed in the pure coal, and of course is correspondingly injurious when employed in iron works.

In making these lumps, all sorts of coal, which have no bad quality, can be employed, probably; but they use, chiefly, the *joan-mei*, because it is so easily reduced to powder. Wagons of coal dust are brought to Pekin, which material is applied to no other purpose than that of making the lumps for burning.

It is unnecessary to follow M. Collas in the details of this manufactory. When moulded, the masses are spread on the ground, and dried, much in the manner of bricks, after which they are arranged in heaps.

Every year, at the commencement of winter, in the houses of Pekin, a considerable quantity of these lumps are made, from the dust and little fragments, derived from all the coal which has been purchased during the year. This appears to be an essential part of the domestic economy of the Chinese. These bricks, thus fabricated from coal dust and clay, serve to warm the apartments when cold weather commences, or when a moderate degree of heat only is required. They are generally of a better quality than those which are sold in the shops, because the latter have more foreign matter in their composition, and, consequently, give out a less intense heat.

The moulds or lumps, made in Pekin, are too large to be put into the ordinary stoves. They are, therefore, broken in pieces, and are either thrown into the stove, indiscriminately with the smaller fragments, or they are separated and the fine portions are moistened with water, and formed into balls, which when dried, burn as well as the larger fragments of the lumps.

Charcoal is employed not only to light these coal fires in the chambers, but to revive the fires, when they have been allowed to become too low or feeble.

Numerous additional details are furnished, the greater part of which are now of every day use in the United States, and familiar to all; yet were only acquired by slow degrees and by considerable practical experience in their adaptation.

The coal which is sold pure, and without these added matters in the manufactured state, arrives in large masses, intermixed with fragments of smaller size. After having broken these masses into pieces suitable for use, the dust or powder, and minute fragments, are carefully collected for the preparation of the mould, before mentioned. The coals employed in domestic purposes, hold a middle rank, between those of the best quality and of the worst. The best, as regards colour, grain, and hardness, seems to be a variety of coal mixed with a stony matter hard enough to give fire with steel. There are several other sorts of coal in various parts of China.

4. M. Cibot furnished M. Collas, with specimens of another description of coal, abounding thirty leagues from Pekin, but which was not then in common use in that city. The Chinese do not call it *mei*, but *che-tan*. Tan is the name they give to wood charcoal. *Che* means a stone. Therefore, according to the genius of the Chinese language, this compound word signifies a substance derived from a stone, or resembling it and charcoal. There can be little difficulty here in recognizing the kind denominated anthracite, in our day.

The coal-bricks or moulds sold a century ago in the Chinese cities, remind us of the compound of culm or coal-dust and clay, so common in South Wales, and which the writer of this saw abundantly made by women and children, and in use at Kidwelly, in 1810. In the year 1840, something of this sort was offered in the United States, as a valuable and supposed new discovery, and some modification of the same thing was, we believe, about the same time patented in England,* and also introduced into France and Germany.

There are other matters, of very ancient usage in China, which, at a recent date, have been adopted in the warming of dwellings in Europe or the United States, through the means of coal and anthracite. Thus, we are informed, that the furnaces or stoves, which warm the floors of the Chinese apartments, are placed below or without the building in a pit or trench, into which descends, twice a day, the domestic who is charged with the duty of replenishing the fire. These stoves are in the form of a truncated cone; and by a flue which passes under the bricks which form the pavement or floor, they communicate an agreeable warmth to each chamber. This method, used for centuries by the Chinese, has been adopted, with little modification, in our own dwellings within a few years, as a useful and economical diffusion of heat, and as the result of modern philosophical investigation.

"On a beau avoir eté a la Chinie, y avoir beaucoup vu, lu et entendu; ou court toujours le risque d' une méprise, quand on se mêle de prononcer sur ce qu' on y sait, ou ce qu' on n'y sait pas, en fait d'arts."†

Even the popular geological speculations, advocated in our day, are but revivals of doctrines taught a thousand or more years, by the enlightened Chinese philosophers and reasoners, before they became known to the Europeans.

"Would you believe, Monsieur," asks one of these enlightened missionaries at Pekin, "that *the central fire, the refrigeration of the planets*, and other such systems, have long been known to the ancient Chinese? Would you believe that these systems have occupied the philosophers and savans, in this eastern extremity of our hemisphere, during many centuries of years

* The English plan patented in 1841, contained two-thirds of earthy matter, and one-third of coal-dust, to which was added some resinous matter.

† M. Cibot sur les Arts, pratiques en Chinie, p. 361.

before the existence of your Druids;—that is to say, at the time when there existed only forests and woods, covering the surface of our Europe, now so fertile and fruitful? Would you believe that these systems, adopted at first with enthusiasm, and extolled with energy, fell, little by little, into discredit; and, finally, were almost entirely forgotten, to reappear in the writings of pretended sages, after more than ten centuries of oblivion?

Yes, the philosophers and their disciples, who lived under the dynasty of the *Soung*, which reigned from the years 960 to 1279 of the Christian era, brought once more to light,—dug from the grave, as it were,—the greater part of these ancient systems; especially those which have affinity to the doctrines of central fires, and the refrigeration of planets; clothed them according to their own fashion; proposed them to their contemporaries; gave them importance, and directed the course which they have maintained to the present day among the literati of the highest class.

One can readily comprehend how many ages have rolled away; how much care, and pains, and toil, it has cost, to men of meditation, to arrive at the degree of civilization which has been attained at the present day. We believe that men have passed, successively, through all the good and all the evil of which their natures are susceptible—that they have been, alternately, barbarous and civilized—that more than once have they invented the same sciences, and the same arts—established corresponding laws, and similar usages; but that these sciences and these arts, at first neglected, then for the most part forgotten, were finally entirely lost, through the effect of those physical and moral revolutions, those catastrophes and ruins, (bouleversemens,) which have changed, from time to time, the aspect of the earth, and were only invented anew, as we have seen, under the reigns of the earliest Emperors of which Chinese history makes mention."*

CHINESE ANTHRACITE.

The Chinese glance coal forms a remarkable exception to the unfavourable conclusion prevailing against oriental coal; and deserves to rank at the head of the list, in respect of its purity as a coke; although, in specific gravity, it does not come up to the character of the English fuel; neither has it the spongy texture which contributes much to the glowing combustion of the latter.†

The Russian authority, M. Kovanko, to whom we have had occasion to advert in another page, shows that this coal formation occurs in the western range of mountains, at about a day's journey from Pekin; which, judging from the usual rate of travelling in that country, probably does not much exceed thirty miles.

We know so little respecting the interior of China, that we are inclined to extend our notice, in this case, further than usual. The carboniferous limestone occurs to the west of Yan-pin-koon. Eastward of that place the regular coal formation is extensively displayed.

Bituminous slate clay is here largely developed, in which thick beds of coal occur. This variety is not of the best kind; it is singularly decomposed, and its particles have so little cohesion, that they are almost reduced to a state of powder. Greenstone, or compact diorite, is seen intruding amidst these slate and coal beds.

Underneath the slate clay are beds of ferruginous sandstone, and beneath

* Extrait d'une lettre de M. Amiot, ecrite de Pé-king, le 2 Octobre, 1784.
† History of Fossil Fuel, 471, and Edinburgh Phil. Journ., 1832, 347.

these are found rich seams of coal, of much superior quality to those which occur in the slate clay.

There are also vertical beds of conglomerate, accompanied by seams of coal, which have the diorite for the floor and the conglomerate for the roof. As might be expected, this coal very much resembles anthracite—because it is shining, of compact texture, difficult to ignite, does not flame in burning, or give out any smoke. Its substance is entirely homogeneous. Every thing respecting it leads to the belief that there had been a great development of heat at the period of its formation, or subsequently.

In other places the conglomerate beds are horizontal. The horizontal coal seams here, lying between the diorite or greenstone, and the conglomerate, are in more important and valuable beds; as, for example, at Daor-yao, where the coal bed is 1¼ archines thick.* The coal of this bed is brittle, breaks easily into small fragments, of the size of a pea. The blacksmiths, and those who work in copper, consider it preferable to any other coal for their use, on account of the intense heat which it gives out.

Throughout this range may be continually seen the outcrops of this combustible, which has never, as yet, been touched by the hand of man. The coal employed as fuel in Pekin, where wood is very dear, is worked on a great scale; but whether in consequence of the abundance of this mineral, or of the prejudices of the Chinese, and their aversion to improvements, the result is, that the process of mining is little understood; while the preparation of charcoal is carried on there with more success and economy than any where else.

Mode of Working or Mining Coal, and Price at Pekin.

It might be expected that in China, where most of the practical arts have, from time immemorial, been carried on with all the perseverance of that industrious people, the operations of mining coal, with which they are cheaply and plentifully supplied, would be conducted with some regard to science, in relation to sinking, draining, and extraction. We have, however, the authority of a Russian engineer officer, Major Kovanko,† a competent judge, particularly with relation to the western coal mountains in the environs of Pekin, that "the art of mining is yet in its infancy among this people." Machinery, to lighten labour, is there unknown; and they have not even an idea of the pumps indispensable to draw off the water. If local circumstances allow, they cut drainage galleries—if not, they abandon the work, when the inundation has gained too far upon them. The mattock or pick-axe, the pick and hammer, are the mining instruments—the only ones, in fact, which the Chinese use in working the coal.

The water of the mines is emptied by the slow process of filling small casks, which are brought up to the surface by hand labour.

Vertical shafts are not used. In working horizontal coal seams, the timbering is expensive, and the materials cost about two copecs per poud‡ = $8.50 per English ton; wood being used by weight in China.

The coal when mined is put into baskets and drawn upon sledges, which are raised to the surface by manual strength. One basket contains about

* The Russian archine or arsheen is 28 English inches.

† Geology of the Environs of Pekin, St. Petersburg, 1840.

‡ A Poud is 43 Russian, or 56 English pounds, equal to the 40th part of 1 ton of 2240 lbs. 10 Roubles is equal to 11¼ francs. The Copec is 100th of the rouble, either of silver or paper. The silver copec being at the rate 0.77c. U. S. The copper copec, 0.193c. U. S.

three pouds of coal, and one man can raise about eight baskets in a day, which is equivalent to 12 cwt. English, or 1032 Russian lbs. The miner receives at the rate of 30 copecs a basket, which is equal to 240 copecs a day, or about 46 cents United States money. This part of the labour, therefore, costs $0.76 per ton United States.

At the place where it is worked, this coal is sold for 60 copecs per poud, = $4.63 per ton. It is conveyed on the backs of mules, through the mountains, and thence on camels to Pekin, where the price is 1½ roubles = 150 copecs = $0.29 per poud; which, if our calculation be correct, is equivalent to $11.60 per ton of 2240 English lbs. = £2 8*s*. 3*d*.

There is, besides, a kind of coal sold at Pekin at a much lower price—particularly when it is mixed with one half of coal dust or detritus. This coal, according to Major Kovanko, sells for only 1 rouble per poud; which is after the rate of $7.75 = £1 12*s*. 3*d*. per English ton. It is of indifferent quality, giving out but little heat, and is quickly consumed. The small coal, in question, is previously mixed with yellow clay, to give it greater consistence.

The process is very simple:—Eight parts of coal-gravel are mixed with two of clay, and sufficient water to render it a thick paste. After mixing to the proper consistence it is put into moulds, in the same manner as in the manufacture of bricks. Thus formed, the pieces are dried and used as coal. They produce little heat, however, and the fire must be constantly fed with fresh doses. This fuel is only used among the indigent classes.

Thus we perceive that the practice which was detailed by the good missionaries, more than seventy years ago, remains in common use in Pekin. We think it extremely probable that the brick form is less favourable to combustion and to the maintenance of steady heat, than the spherical masses, which permit so much greater space for the passage of the air; and that this circumstance may readily account for the intensity and durability of the heat, where the latter shape is adopted, as in Wales.

Freights from Europe to China, in 1844, from £3 10*s*. to £4 = 87*fr*. to 100*fr*. per ton of 1016 kilogr.

Freights from Hong-Kong to Europe, in 1844,

For London or Liverpool, £3 sterling = 75*fr*. per ton of 50 cubic ft.

For other European ports, 10*s*. more per ton, or in all = 75*fr*. 50*c*.

FORMOSA,

Between 22 deg. and 25 deg. 30 minu. north latitude.

This island, which chiefly belongs to China, is imperfectly known to the geologist, particularly on its eastern side. In addition to rocks of igneous origin, others of sedimentary formation are stated to prevail, some of them containing coal.

We learn from a paragraph in the "Friend of China," that Rear Admiral Sir Thomas [Cochrane?] has visited the island of Formosa, in order to ascertain the accuracy of the report, that coal was here to be found. At a distance of a few miles from the shore, there is coal which was reported to be of excellent quality. This is certainly a most important discovery. An abundant supply of cheap coal is now of the greatest consequence both to the royal steam navy and the mercantile vessels running to and from China.

If coal can be laid down in Hong-Kong—and it is said that it can—for two dollars a ton, the saving to the steam vessels employed in the China seas will be immense. It will at once remove the great drawback upon

steam navigation on the coast, and on the Canton river, and will be in the highest degree beneficial to the foreign commercial interests of China.*

Specimens of coal from Formosa were exhibited to the meeting of the Geological Society of London, Nov. 19, 1845, but it did not appear from the notice, under what geological conditions the coal existed.

An English vessel of war, the Royalist, was sent to survey the coast of Formosa, and devoted the year 1846 to that service. According to the report of Lieut. Gordon, to whom was assigned the narration of this duty, the shores of Formosa offer, in several places, considerable beds of coal, of an excellent quality.

Admiral Cochrane had previously obtained specimens of coal from the same locality, but that which was last discovered burns much more freely.

This discovery has given rise to negotiations with the Chinese government, in order to obtain permission for the English steamers to stop at Formosa.

Naphtha is abundant in the ancient volcanic region of Formosa.

ARCTIC OCEAN.

NEW SIBERIA, FADVESKOI, KOTELNOI,

And a group of several other Islands, situated between north latitude seventy-four degrees, and seventy-six degrees opposite to the Cape Swatainos [or the Sacred Cape,] on the coast of Siberia, are remarkable for the quantity of large fossilized trees which they contain; besides the immense accumulations of fossil bones of elephants and rhinoceros. These have been described by the Russian explorers, Hederstorm and Baron Wrangell. Although these lignites, so different from the scanty vegetation that now barely exists so near to the North pole, cannot be classed with the regular deposits of true coal, we have not scrupled to advert to them here, on account of their remarkable geographical position.

The *Lachow Islands*, in the Polar Sea, and in the same latitudes, were found by Sannikow, another Russian explorer, to contain similar fossilized trees and an enormous quantity of bones, of seven or eight large quadrupeds, chiefly those now belonging to warm climates.

The Island of New Siberia, only twenty-five versts in breadth, is remarkable for a mountain on its south-eastern coast. It is composed of alternate horizontal layers of a greyish freestone and a shining bituminous wood. This coal is so hard as to be cut with difficulty with a knife. At the summit of the hill, this bituminous wood, which at the bottom, is found in horizontal layers, is placed vertically; standing out above the surface, like piles which had been regularly driven.†

* "The Friend of China," Jan. 21, 1846. † Recollections of Russia, p. 116.

SIBERIAN ICY SEA.

The wood hillocks, as they have been called, and described by Baron Wrangell, consist of an accumulation of trunks of trees, and a vast quantity of drift wood, washed down by land streams, and brought together by ocean currents.

The wood hills of the southern shore of the island of New Siberia, discovered in 1806, consist of elevations of about thirty fathoms, made up of horizontal layers of sandstone, alternating with bituminous trunks of trees. On the tops of the hillocks the stems stand erect. The strata of drift-wood are visible for five wersts, or three and one-third English miles.*

* Wrangell and A. Von Humboldt.

AUSTRALIA,

COMPRISING

1. NEW SOUTH WALES.
2. SOUTHERN AUSTRALIA.
3. WESTERN AUSTRALIA.
4. VAN DIEMEN'S LAND.

NEW ZEALAND,

COMPRISING

1. NORTHERN ISLAND, OR NEW ULSTER.
2. MIDDLE ISLAND, OR NEW MUNSTER.
3. CHATHAM ISLAND.—CHATHAM ISLAND IN POLYNESIA.

AUSTRALIA.

NEW SOUTH WALES.

NEWCASTLE AND RIVER HUNTER REGION OF BITUMINOUS COAL.

The Newcastle coal occurs in several horizontal beds, alternating with slaty clay, sandstone, and shale, with vegetable impressions; also a rock resembling the millstone grit, and a hard cherty rock. Nodules of clay-ironstone, and trunks and stems of arundinaceous plants, in similar ironstone, are abundant in the alternating strata.*

The coal country south of Hunter's river, is described by Mr. A. Berry, member of the legislative council of the colony. The cliffs on the sea-shore present a most interesting section of the strata. There, in one day, more information may be obtained than in any other place during years. He traced these strata for nine miles, when they abruptly terminated; or rather were concealed by suddenly inclining downwards, below the sea level. The south head of Lake Macquarrie rises into cliffs, in which the coal strata again ascend and present themselves. Between the coal seams are beds of sandstone and of slate clay, with vegetable impressions, and abundance of layers of argillaceous iron ore, which is occasionally cellular, but, for the most part, appears in the form of petrifactions of trees and their branches. At one point, two large coal beds gradually approach, and at length meet, and continue parallel. At the same place is a bed of highly indurated overlying conglomerate, which reaches from the surface of the coal to the top of the cliff. The fibre of the wood is often quite distinct.†

At about three miles along the south coast of Newcastle, was found the butt of a petrified tree, in an upright position, at high-water mark, under the cliff and beneath a bed of coal. This trunk, on being broken, presented an appearance approaching to jet. On the top of the cliff at Newcastle, lying in a horizontal position, was observed another trunk of a tree, which was finely grained and white. Both of these specimens were traversed by thin veins of chalcedony.‡

Near this place, on the south-east line of coast, the cliffs before mentioned, which rise from one hundred to three hundred feet above the sea, were burning a few years ago. They contain sometimes two and sometimes three coal seams.

In the upper part of the district of Hunter's river, is Wingen, the only burning mountain within the present limits of the colony, and is 1400 or 1500 feet above the sea. Bitumen proceeds from it, and the whole appears

* Australian Almanac, 1836.

† Proceedings of the Royal Society of London, Vol. IV. p. 299.

‡ Rev. C. P. N. Wilton, 1831.

to have been on fire for a great length of time, as if from the ignition of coal beds.

Mr. Wilton states that on the coast a bed of brown coal was discovered in 1830, beneath the bed of conglomerate spoken of. "This brown coal, which varies from eight feet to thirty feet in thickness, is described as passing into the black coal," and appears to have been on fire at no distant period.*

The discovery of coal in the colony did not take place until comparatively a late period. A writer, in 1829, remarks with much satisfaction, that "there is now a certain prospect that the town of Sydney can be supplied regularly with coal from Lake Macquarrie. It burns and cokes as well as the best English coal."†

The Australian Agricultural Company are working the coal here, and in 1840 sold 27,000 tons from hence. It is remarked that the coal seams on this coast are occasionally affected by vertical faults.

This district afforded to the naturalists of the United States exploring expedition, a characteristic series of the coal plants. We have had a brief opportunity of inspecting these specimens in the national collection at Washington. They have not yet been described. They comprise lignites or stems of dicotyledonous trees in considerable quantity, and have not the usual characteristics of the European coal measures, but have a newer aspect. With the undetermined fossils, we observed the following genera:—*Sphenopteris, Glossopteris, Phyllotheca*, and obscure specimens of a plant to which the name of *Zeugophyllites* has lately been given. They are imbedded in grey carboniferous sandstone and in greenish clay slate. We are informed by Dr. Pickering that a great quantity of silicified wood is scattered over the surface on the Upper Hunter. An *Icthyolite* was discovered here by Mr. Dana.

The most prevalent fossil plants of the New Holland coal strata is the *Glossopteris Browniana*.

It is proposed to smelt the copper ores of South Australia in that country, instead of sending them to Swansea, as heretofore. Newcastle is recommended as offering the best position for smelting establishments. The supply of coal may, for the present generation, be said to be unlimited, and the quality is excellent. The price charged in 1846 by the Australian Agricultural Company, is seven shillings per ton. But on an extensive scale, coals could be supplied for five to six shillings, = \$1.20 to \$1.45 per ton, which is about the price at Swansea smelting works, in South Wales.‡

MORETON BAY.

At sixty miles up the Brisbane river, which falls into Moreton bay in S. Lat. 27°, Mr. Cunningham, in 1835, examined a large seam of coal in the channel. On Brenner river, which falls into the Brisbane, another coal bed was observed, and was traced from that river to the Brisbane.

PORT JACKSON.

Mr. Scott has described the coal measures along the coast, from Port Stevens, about S. Lat. 33°, to Cape Howe, S. Lat. 37°. On the road to Bathurst, a few miles below the pass of the Blue Mountains, there is a moun-

* London and Edinburgh Philosophical Magazine, Aug. 1832, p. 39.
† Peter Cunningham, 1829.
‡ Maitland [New South Wales] Mercury, 1846.

tain which contains much coal. It lies immediately below the surface. It burns with a bright flame, giving much smoke, but leaving very little cinder.

MOUNT YORK,

The highest peak of the Blue Mountains, situated in S. Lat. 33° 30′, is 3292 feet above the sea. Mr. Duperrey observed stratiform lignite at a great elevation on this mountain. We are hence led to the conclusion that the ferruginous sandstone with which all this country abounds, and forms the Blue Mountain range, belongs to a tertiary period.*

MURRAY RIVER.

In 1846 was discovered a stratum of coal about thirty-five miles south from Freemantle, near to the Murray river. From the accounts received in the colony, it is thought to belong to the regular coal series, rather than to a lignite formation.

Some seams of bituminous coal were discovered on the Murray, south of Perth, in December, 1846. A fine bed has also been found on the Irwin river, about two hundred miles north of Freemantle, and forty miles inland. There are two of these beds; one five, the other six feet. The statements are somewhat confused, as another account, in December, 1846, states that a bed of coal had been discovered at a point supposed to be about one hundred and fifty miles to the north north-east of Perth.

PORT WESTERN, OR WESTERN PORT.

Near Port Philip, in Lat. 38° 30′ S., and Long. 145° W., an exploring party discovered bituminous coal, in 1840. The quality was satisfactory, but it was some distance from water carriage. Various seams were reported, which varied in thickness from two inches to four feet.

In 1841, Mr. Cameron, who was appointed by the government to inspect this coal, returned from the expedition with a report of having proved several beds. The principal seam is situated about fifteen miles from the water's edge, which would render a railroad necessary for the conveyance of the fuel to the landing. Its proportion of bitumen was stated to be large. A subsequent report, by the same person, corroborates, in great measure, the previous statements; but a difficulty arose from the "inclination of the strata."

At Cape Liptrap, in this vicintiy, further traces of mineral coal have been observed.

PHILIP ISLAND.

Coal beds were found in 1840, and in consequence of this and of the discoveries near Westernport, especially under such auspicious circumstances for transportation as this island afforded for mining coal, a company was formed, called "The South Australian Mining Association." We hear of no further progress in mining in this island; but in 1846 a geological investigation determined the existence of some large seams of coal extending over a greater area than had been anticipated.

RESERVATION ISLAND, IN BASS STRAITS.

Mineral or fossilized wood was observed here by Captain Flinders. It denotes apparently an extension of the carboniferous sandstone existing at Lake Macquarrie.

* Dr. Fitton, in the Appendix to King's Voyage.

Newcastle Coal-field.

Supposed brown coal and silicified lignites of Kurrur-kurrân, at Lake Macquarrie.

Within the Inlet of Awaaba, also called Lake Macquarrie, latitude 33° S. the Rev. W. B. Clarke examined a remarkable lignite deposit which he has described under the title of "a fossil pine-forest," fourteen miles to the south of the mouth of the Hunter river.

The area in question "occupies part of that formation of conglomerate and sandstone, with subordinate beds of lignite, which extends from the Hunter river, southwards, towards Brisbane water. The lignite constitutes the so-called Australian coal. This formation, owing to its beds along the shores of the inlet, being horizontal, and divided by nearly vertical joints, occasions great regularity in the coast line, both longitudinally and transversely. It forms a high range which divides the lake from the sea."

Kurrur-kurrân is a low flat, of no great magnitude, upon which are seen fossilized stumps and stools of trees, standing vertically out of the ground, like the stumps in an American clearing. In the lake, also, where it adjoins the flat, to the distance of from 80 to 200 feet from the shore, numerous points are seen, like those of a reef of rocks, just peeping above the surface of the water. These pointed bodies are the fossilized stools of trees, similar to those on the shore. The stumps have their roots imbedded in the sandstone, and are two or three feet above the surface, and from two to four feet in diameter, in which from 60 to 120 concentric rings of growth may be counted. The wood appears to be coniferous. Veins of chalcedony traverse the substance of the trunks, between the concentric rings, and also in the direction of the radial lines. Many of the stems have their bark adhering firmly, and in one instance it was three inches thick.

Immediately *below* the flinty stratum in which the trees are rooted, is a bed of lignite. *Above* the stratum, and imbedded in sandstones and conglomerate, immense quantities of fragments of trees occur; and among other forms, is the genus *Glossopteris.*

Fossil trees are found in this formation at other places, and nearly on the same level as that described; immediately above and below a bed of lignite. Several of these positions are noted by Mr. Clarke; extending to the Hunter river. The prostrated trees are from ten to one hundred and fifty feet long; and the writer infers that the sandstone bed, which supports the lignites at Kurrur-kurrân, is the true geological site of that ancient forest, from which such enormous quantities of fragments of wood have been derived, in various parts of the colony.

This sandstone is traversed by trap dykes, and according to M. de Strzelecki, contains fossils of the carboniferous or Palæozoic period.

The author mentions two beds of lignite, (coal?) one above the bed of fossil trees, the other below it; but he does not describe the relative position and characters of these two beds, nor the quality of the coal or lignite.*

Mr. Clarke's report has done little, towards determining the age of the coal deposit of this coast, which he considers as brown coal. The trunks, boughs, and roots of trees, described by him, are evidently closely associated with these lignite beds. Some of the stems are spoken of as hollow, but the greater part are said to be solid; with a thick bark, and concentric rings of growth, and apparently coniferous. It is remarkable that Count

* Proceedings of the Geol. Soc. of London, Vol. IV. No. 94, p. 161, 1843.

Strzelecki expressly states that no traces of conifera have yet been discovered in this Australian coal-field, which he evidently refers to the carboniferous or newer Palæozoic period, but having some vegetable forms which approach to certain species in the oolitic coal of England: the whole overlying the older Palæozoic rocks. In comparing the fossil fauna of this older series, with that of the Palæozoic rocks of other countries, M. de Strzelecki found some of their forms to be identical, and others to be representative species.

The unusual interest which attaches to these remote coal-fields, respecting which there are such conflicting views, leads us to pursue this subject somewhat further.

Among the most recent scientific works, relating to this portion of the globe, is the "physical description of New South Wales and Van Diemen's land, by Count Strzelecki, 1846. This work is the result of five years of continual labour occupied in travelling on foot, for a distance of 7000 miles, through various parts of the eastern shores of the vast island continent of Australia, and in the island of Van Diemen's land.

The plan of our present volume permits us to quote only that part of Count Strzelecki's work which refers to the carboniferous series. He states that this series forms a basin shaped deposit in New South Wales, to which he gives the name of the Newcastle basin.

Newcastle Coal-field, or Basin of the Hunter.

This occupies a tract which extends, for some distance, on both sides the Hunter river, near its mouth, in about 33° S. lat. Near Lake Macquarrie the coal is worked, and the section of the shaft exhibits the following coal seams.

	Thickness.
1st bed above the conglomerate,	3 feet.
2d " " "	5 "
3d " " "	5 "
4th " " "	3 "
5th " " "	3 "
Coal,	19 in 204 ft. of strata.

The author does not positively define the age of this coal-field, except that the rocks are of the carboniferous period, containing *Spirifers*, *Conulariæ*, and *Productæ*, and that the whole series are more recent than the Devonian system of Europe.

It appears certain that the formations beneath this coal series belong to fossiliferous stratified rocks, which are referable to the Palæozoic period, both in New South Wales and Van Diemen's Land.

On the south part of the coal-field, at Lake Macquarrie, the coal crops out from beneath a sandstone containing mica and iron glance.

The fossil plants obtained from the coal measures, and described in the work before us, are but few. They are referred to three species of *Sphenopteris*, one of *Glossopteris*, two of *Pecopteris*, one *Zeugophillites*, and one *Phyllotheca*.

There are no traces of any of those remarkable genera so characteristic of, and so abundant in, the strata of the European and American coal-fields, such as *Lepidodendron*, *Sigillaria*, *Stigmaria*, *Calamites*, or *Coniferæ*.

In comparing the coal-field of the Hunter with that of Van Diemen's Land, he observes that "the basins, themselves, indeed contemporaneous, appear to be characterized by a distinctly localized flora; no species, as far

at least as our observations have extended, being found common to the two deposits.

The basin of the Hunter contains *Phyllotheca Australis*, *Glossopteris Browniana*, and some other species. In the basin of Jerusalem, in Van Diemen's Land, are found three or four species belonging to the genera *Sphenopteris* and *Pecopteris*, and one to *Zeugophyllites;* these being associated with some large fragments of stems, too imperfect to be defined.

In comparing, therefore, the whole of the species at present known, from these deposits, with the coal plants of Europe, there appears, indeed, to be but few, if any, analogical forms; although the equisetoid-looking *Phyllotheca* may probably be considered as the representative of the *Calamites* of the northern deposits; whilè, on the other hand, its congener, the *Glossopteris Brownania* is a fern entirely different from any of those that are found in the carboniferous periods of the northern hemisphere.

These few observations partly lead us to infer that the flora of the southern hemisphere was perfectly distinct in its facies from the northern, at the carboniferous period; just as, at the present time, the modern flora of the same continent presents a striking difference to that of other portions of the globe; and this appears to be the more remarkable, as the species constituting the fauna of the Australian ocean, anterior to that period, contain many forms which, if not perfectly identical, are at least the representative ones of those of the northern region.

Comparison of the fossil vegetation of New South Wales with that of the Burdwan Coal-field in Bengal.—" In instituting a comparison between the species collected from the Australian deposits, and those described from the Burdwan coal-field by Professor Royle, we observe both the remarkable analogy of form of some species and the actual identity of others; from which we may probably be led to infer that the deposition of the strata containing them was not only contemporaneous, but that the conditions of the flora of some portions of the Indian and Australian continents, at that epoch, were not very dissimilar.

In the Burdwan coal-field we find the *Pecopteris Lindleyana*, *Glossopteris danæoïdes*, *G. Browniana*, and other plants, associated with two species of a very curious form, *Vertebraria indica* and *V. radiata*. The Australian deposit also contains *Glossopteris Browniana*, two or three species of *Sphenopteris*, and the same species of *Vertebraria* above noticed. The *Pecopteris Australis* of the Jerusalem Basin of Van Diemen's Land is closely allied to, if not identical with, the *P. Lindleyana* from Burdwan.

The *Glossopteris danæoïdes* of the Burdwan deposit apparently belongs to the genus *Tæniopteris*, the veins being perfectly horizontal, and not anastomosed, as in the typical species of *Glossopteris*. We have previously remarked upon the absence of certain carboniferous forms in these deposits; on the other hand, if we compare some of the species with certain others, from the oolite series of England, a striking analogy of form is at once perceptible.

The *Pecopteris Murrayana*, *P. Whitbienis*, and *Glossopteris Phillipsii*, representing, as it were, the *Pecopteris* [*Sphenopteris*] *alata*, *P. Australis*, and *Glossopteris Browniana* of the Australian strata."

On the whole, it is alleged, the flora of the coal-fields of *Australia* has a striking resemblance to that of the Yorkshire oolites. It is possible that the coal of New South Wales, and of Northern India may really belong to the Jurassic system.*

* Annual Address to the Geol. Soc. London, 1846.

Notwithstanding these conclusions, we observe that at the meeting of the British Association, in 1846, Dr. Falconer is reported to have remarked, that the Burdwan coal, as it contained neither dicotyledonous nor coniferous wood, was probably *older* than any of the English coal-fields.*

PROSPECTS OF THE COAL TRADE OF NEW SOUTH WALES.

Mr. Dutton is of opinion that the extensive coal-fields, north of Sydney, will, at a future day be made available, to a considerable extent, as the colony becomes more densely settled. The Australian Agricultural Association, in whose hands is the monopoly of the coal mines, at present, ought to be the first, to turn their attention to the subject.

The port of Newcastle, on the Hunter river, is quite as convenient for the erection of smelting establishments, as Swansea. Here the copper of South Australia might be sent to be smelted, if furnaces were erected. Coal exists here to an unlimited extent; and the demand does not take off a tithe of the quantity that could be raised from the three pits, over which powerful engines are already erected. Vessels of three or four hundred tons can lie at this port in perfect safety, and approach the end of the coal slips.

The seam at present worked is not more than twenty fathoms below the surface, and not more than twenty yards from the water. Under the colonial regulations, it appears, that this is the only pit allowed to be worked; giving its owners a complete monopoly, against which a very strong feeling of dislike naturally exists in the colony, and many attempts are daily made to evade it. Nor is this to be wondered at, where so many individuals have property containing coal, with equal facilities of position.†

We see here repeated precisely a similar pernicious state of things as is inflicted on an opposite part of the world. "The General Mining Association," are lessees from the crown of all the coal and minerals of every description in the province of Nova Scotia and the island of Cape Breton:—that is to say, a monopoly which engrosses an area of no less than seventeen thousand five hundred square miles; to the exclusion of the owners and occupiers of the property throughout that extent. The paralyzing influence which it exerts on the British colonies in that quarter has long been matter of complaint with the people; and, in 1846, formed the subject of a memorial from the house of assembly, in which it was urged that twenty of the sixty years of the lease to the association had expired, yet no effort had been made to work a single bed of coal, or other mineral, with the exception of the coal beds at Pictou and Sydney.

SOUTH AUSTRALIA.

Mr. Dutton, in his letters on the mineral wealth of South Australia, June 1846, states that the existence of coal here, has been reported, but is not yet

* Athenæum, Oct. 1846.
† Dutton on the Mineral Wealth of South Australia, 1846.

verified. Even if it should not be, the unbounded extent of the forests—the wood of which, when dried, burns with an intense heat and steady blaze, from the resinous matter which it contains, and makes most excellent charcoal—will enable the same operations to be carried on in smelting, as has for centuries been adopted in other mining districts where coal does not exist.

Mr. Fortnum reports on the existence of the old red sandstone, or its equivalent, in the interior, but is at present doubtful as to the presence of the carboniferous series.*

The chief mineral riches, at present developed in South Australia, are the splendid mines of copper. But these, if the smelting be effected in the country, will give great stimulus to the increased production and consumption of the coal in the adjoining colony of New South Wales.

WESTERN AUSTRALIA.

Iron is so plentiful here, that it has attracted the attention of the settlers, in a variety of places. Hitherto, coal has not been discovered, in this quarter, wherewith the former mineral might be manufactured.

The government, with a view to stimulate researches for this combustible, has, it is said, offered a reward of two thousand five hundred acres of land to any one who shall discover coal; but the more urgent operations of the settlers have hitherto prevented any attempt being made. However important the possession of coal may prove, it is now, while such stores of forest wood abound, indispensable to the production of good iron.†

1847.—It is announced that coal has been discovered in this country.

VAN DIEMEN'S LAND, OR TASMANIA.

Here coal occurs, very plentifully, in sandstone, as in New South Wales. We have reports of a mineral survey of the newly discovered coal-fields, upon the estate of Messrs. Bonney. An extensive bed of fine coal dips to the northward, and passes under the Coal river, at an angle of about thirty

* Mining Journal of London, June, 1846.
† Australian Journal. Also Mining Journal of London, August 3d, 1844.

degrees. It is upwards of three feet thick, at the outcrop.* Coal is stated to be traceable quite across the island.†

In the "Tasmania Journal," appeared an account, by Dr. T. P. Hooker, assistant surgeon to H. B. M. S. Erebus, of fossil wood found on this island, at Macquarrie Plains.‡

M. de Strzelecki shows that there are two basin-shaped coal deposits in Van Diemen's Land.

1st. The *South Esk Basin*, although much broken and apparently very limited in extent, agrees with that of Newcastle, in New South Wales in its general geological characters. A variegated sandstone overlies the regular coal measures. The fossils are the same as in the Newcastle basin of New South Wales.

2d. The *Jerusalem Basin* is situated not far from Hobart Town to the east. The underlying bed is a limestone, containing *Productæ* and *Spiriferæ*, succeeded by a conglomerate on which the coal measures repose.

In this series are proved,	1 coal seam of	3 feet.
" " "	2 "	2
" " "	slates and clays,	53

Total shown in the shaft of the Jerusalem pits, 58 feet.

Some of the coal in the Jerusalem basin is described as anthracite.

It appears from the memoir of M. Strzelecki that the greater part of the Palæozoic rocks which he examined in Australia and Tasmania, are the equivalents of the Devonian series.

Among the fossil plants collected from the Jerusalem basin, we find the interesting genus *Zeugophyllites*, and certain forms of *Pecopteris*, one of which is closely allied to an oolitic species, and another having strong resemblances to an *Odontopteris* from the Permian system of Russia.§

The late work of M. Corda, contains a description of an arborescent fern, from Van Diemen's Land, which he conjectures to be *Balantium antarctium* [*Dicksonia antarctica*, Hooker,] and which approximates closely to the fossil *Protopteris cottai*, found in Saxony.

Some interesting traces of the newer tertiary period appear in the remarkable opalized trees which are spread over the surface in some of the valleys, especially in Derwent valley, Van Diemen's Land, and recently described by Dr. Hooker, the naturalist in the expedition of H. M. S. Erebus.

* Hobart Town Advertiser, November, 1840.

† Colonial Statistics of the British Empire, Martin, p. 441.

‡ Transactions of the Geological Society of London, February, 1843.

§ Physical Description of New South Wales and Van Diemen's Land, by P. F. Strzeleck 1846.

NEW ZEALAND.

This highly interesting country forms, we are told, a group of mountainous islands, as large as England and Wales. Its geological character is rendered difficult of discovery by the primitive forests that fringe the coast, or, where these have been destroyed, by impenetrable thickets of the esculent fern.

The fundamental rock is every where clay-slate.

NORTHERN ISLAND, OR NEW ULSTER.

The colonists at Wellington and Port Nicholson, on the north shore of Cook's Strait, are gratified at the discovery of coal at various places in their neighbourhood, particularly at Port Nicholson Harbour itself. They conceive that the production of coal, here, will benefit the trade of the colony, by enabling the vessels from Australia to India to land cattle, and to load coal for Bombay and Calcutta.

EVAN'S BAY, NEAR PORT NICHOLSON.

On the shores of this bay indications of coal have been found; and were, they followed up, it is reasonable to suppose that they would lead to productive seams, as it exists in many places about Cook's Strait, in great quantities.

Mr. Heaphy mentions that the principal New Zealand coal-fields are at Wanganui, on the Middle Island; at Coal Bay, in Tasman's Gulf; in Palliser Bay, near Port Nicholson; and at Waitotara and Waimate, on the coast between Wanganui river and Cape Egmont. A small quantity has also been found by Captain Wakefield, in the cliffs, on the shore of Nelson Haven.*

River Thames, or Wai-hou district.—Coal of good quality, has been found here, in abundance, near the surface.

* Narrative of a residence in New Zealand, by Charles Heaphy, 1842.

NEW PLYMOUPH, TARANAKI.

Mr. Henry Weekes describes some lignite, or tertiary coal found here. He remarks that it seems even more recent than Bovey coal, that "it can hardly be called coal," and is unfit for domestic purposes.

Mr. J. Perry informs the directors of the New Zealand company, February, 1842, that he had just discovered three beds of coal. They are about four feet in thicknes, and sixteen feet apart; and about five miles from New Plymouth, adjoining the sea-shore, and easy to be exported.*

Mr. Henwood says that here is plenty of coals, and some culm.

On the Waitara river, coal was found on the banks of the river, and also abundant at twenty-five miles further up the coast to the north-east, from Waitara, at Mokau river. A resident describes it as "capital, and plenty of it."

In February, 1847, a coal seam was opened at Montgonin. This combustible was tried on board H. B. M. steamer Driver, and proved to be very good,—quite equal, it is reported, to that obtained at New South Wales.

Coal has been seen near Manakao and toward the Bay of Islands. A shaft was sunk at Mauharangi, near the Kawau copper mine, but having been undertaken by a person of small means, it was abandoned, after sinking about eighty feet.†

PORT NELSON.

Coal has been discovered near Port Nelson, and has been submitted to experiments on board her Majesty's steam sloop, the Inflexible, at Auckland, New Zealand, rumour announcing it of excellent quality.

This discovery is deemed of the highest importance to the commercial interests, and especially as affording the means of a rapid communication between this colony and other portions of the globe.

The experiments, referred to, which were made by order of the colonial government, are to the following effect, as officially reported in the New Zealand Government Gazette, of March 31, 1847.

By a comparison with the best Newcastle [Australia] coal, obtained at Sidney, the following was the result:—"From about equal quantities of fuel, equal work has been obtained; but there is one peculiarity in the Nelson coal, which is, that it is much slower in combustion than the Newcastle coal, and, therefore, would not furnish steam for the cylinders with equal rapidity, to enable the vessel to go at her greatest speed in smooth water; but is far more economical, when all weathers are considered." These trials were made on thirty-three tons only, and the coal could only be regarded as crop coal, which had, moreover, laid for six months on the open beach. The commander of the steamer proposed to renew the trials with not less than one hundred tons.

* New Zealand Journal, also "Letters from Settlers in New Zealand," 1843.

† Mining Journal, 20th September, 1845.

MIDDLE ISLAND, OR NEW MUNSTER.

NELSON HAVEN AND TASMAN'S GULF.

Coal was found by Captain Wakefield, in the cliff which overhangs, in one place, the beach of the haven. It is in a small quantity, but as it exists in so many other places in the vicinity, it is not improbable that it will be found to extend to larger beds.

WANGANUI.

Round Cape Farewell, from Cook's Strait, but only a short distance overland from Coal Bay, in Tasman's Gulf, is the harbour of Wanganui, where coal exists in great quantity. One cargo of this coal was taken to Wellington; but in consequence of the abundance of other fuel, it was used only by the smiths. It was an excellent *anthracite* coal, and gave a great heat; leaving no ash, but burning quickly.

It is found on the beach, below high-water mark, in the river bed, and on the perpendicular side of a small island in the harbour. To obtain it, it will not be necessary to mine, but merely to excavate horizontally through the cliffs, from the beach. Even this trouble is not at present needful; as there is enough on the surface for the supply of all the New Zealand settlements for twenty years to come. Coal also exists on the opposite side of the promontory, at Coal Bay; but no harbour is known in its vicinity.* This statement is confirmed by Mr. A. Majoribanks.†

Another writer describes a bed of coal, three feet thick, resembling Staffordshire coal, discovered in 1842, near Cape Farewell.‡

At *Massacre Bay*, not far from Nelson, coal, accompanied by iron-stone has been found, and has occasioned the change of name to Coal Bay.§

A company was soon after formed for the working this coal, and a cargo was delivered at Nelson. It is described as burning well, and giving out a great deal of gas. The coal was sold for £1 7*s.* 6*d.* a ton, wholesale; and retailed at £2 a ton.

The emigrant vessels find it to their interest to carry return cargoes of this coal to India; and, altogether, it is considered of great importance to the colony.

Dr. Dieffenbach, who has furnished an account of the geology of New Zealand, states that anthracite coal crops out in the small harbour of Wangarrie, on the west coast of Middle Island; and also that there is a thin seam of anthracite in the hard gray sandstone on the east coast of the Northern Island.||

Bitumen has been reported on.

* Heaphy's Narrative of a residence in New Zealand, p. 103, 1842.
† Travels in New Zealand, Majoribanks. ‡ Mining Journal.
§ Emigrant's Letters, p. 77, 82, 119—1843.
|| Report of the British Association for 1845.

CHATHAM ISLAND, [East of New Zealand.]

Mr. Heaphy remarks that the existence of coal on this Island will be a matter of much importance, in the event of a line of steam communication being established between New Zealand and South America.*

Port Wakefield, in this Island, is 360 miles east from Port Nicholson in Middle Island, new Zealand. Long's Bay or Coal Haven, as the name imports, contains coal in the vicinity.

CHATHAM ISLANDS.—POLYNESIA.

One of the chain or group of the Carolines, in the North Pacific Ocean; in about ten degrees north latitude, and one hundred and seventy-two degrees east longitude.

The principal island, which is partly secondary and partly of volcanic origin, and 305,000 acres in extent, contains an extensive formation of lignite, sometimes composed of stems of trees, and sometimes of peaty matter. In one place this peat was observed to be on fire, burning slowly under the surface.†

* Heaphy, p. 124.

† Dr. E. Dieffenbach, communicated to the Geographical Society.

TABLES OF ANALYSIS

OF ABOUT ELEVEN HUNDRED SPECIES OF MINERAL COMBUSTIBLES, DISPOSED IN GEOGRAPHICAL ORDER, IN CONFORMITY WITH THE ARRANGEMENT OF THIS WORK.

AMERICA.

Semi-bituminous or dry Coal.

State and county.	Locality.	Designation of coal beds.	By whom analysed.	Spec. gra'ty.	Analysis. Carbon.	Volatile matter.	Ashes.
TENNESSEE.							
	Cumberland mountains,	Kimbrow's Vein,	Dr. Troost,	1.450	71.00	17.00	12.00
	"	Gillenwaters,	"	1.450	69,00	14.00	17.00
KENTUCKY.							
	Hawsville,	Splint or cannel coal,	Dr. Jackson,	1.250	48.40	48.80	2.80
	Caseyville,	Bitum's coal,	Johnson,	1.392	44.49	31.82	23.69

Fat Bituminous Coals in Western Virginia.—State Reports.

County.	Locality.	Designation of coal beds.	Analysis. Carbon.	Volatile matter.	Ashes.
[Upper coal series.]	Clarksburg,	Main seams,	56.74	41.66	1.60
	"	"	49.21	45.43	5.36
	Pruntytown,	"	57.60	39.00	3.40
	Morgantown,	"	60.54	37.30	2.14
Lower coals—Valley of the Ohio. Kanawha,	1, Coal creek,	Judge Summers's bank,	55.55	41.85	2.60
"	2, Grand Creek,	"	52.75	43.20	4 05
Logan,	3, Wolf creck, Big Sandy river,	Burning spring,	47.15	48.00	4.85
Kanawha,	4, Big Coal river,	(Lewis')	50.20	47.10	2.70
"	5, Three mile creek,	Cartrell's,	45.95	50.30	3.75
"	6, Elk river,	Friend's mines,	55.90	39.90	5.20
Logan,	7, Logan Court-house,	Lawson's,	58.35	39.50	2.15
"	8, Guyandotte,	Traa fork,	56.50	42.00	1.50
"	9, Big Sandy river,	Pigeon creek,	55.00	41.00	4.00

Moderately Bituminous Coals in Western Virginia.

County.	Locality.	Designation of coal beds.	By whom analysed.	Analysis. Carbon.	Volatile matter.	Ashes.
Formation No. XI., Rogers.						
		Little Sewell Mountain,	Wm. B. Rogers,	80.24	17.48	2.28
		"	"	77.64	17.36	5.00
	Big Sewell Mn. E. side, W. flank,	Roger's seam,	"	75.88	22.32	1.80
		Tyree's bed,	"	67.84	30.08	2.08
	"	Deem's "	"	71.73	27.13	1.14
Fayette,	Mill creek,	Paris's bank,	"	71.88	26.20	1.92
	Scrabble creek,		"	63.36	29.04	7.60
	Bell creek,		"		32.16	
Lower Coal series in the Valley of the Kanawha.						
	Keller's creek,	Hansford's	W. B. Roger's state report,	60.92	37.08	2.00
	Second seam,	Storkton's mine	"	74.55	21.13	4.32
	Campbell's ck.	Ruffner's 2d sm.	"	55.76	32.44	11.80
	"	Noyes' seam,	"	64.16	32.24	3.60
	"	"	"	65.64	31.28	3.08
	Cox's creek,	3d seam,	"	51.41	42.55	6.04
	Faure's bank,	Upper seam,	"	53.20	35.04	11.76
	L. Ruffner's bk.	"	"	49.84	44.28	5.88
	Bream's bank,	3d seam,	"	57.76	33.68	8.56
	Smither's bank,		"	54.52	29.76	15.76
	Hughes's bank,		"	62.32	32.88	4.80
	D. Ruffner's bk.	Upper seam,	"	57.28	35.08	7.64
	Warth's bank,		"	54.00	39.76	6.24
Semi-Bituminous or Dry.						
Montgomery,	Thom's creek,	Strouble's run,	Wm. B. Rogers,	80.20	13.60	6.20
	Lewisburg,		"	78.84	14.16	7.00
Botetourt,	Catawba,		"	78.50	16.50	5.00
Hampshire and Hardy counties,—Basins containing the Lower Coal Series.						
Hampshire,	Brantzburg, N. br. Potomac,	2 m. above m. of Savage,		72.40	19.72	7.88
"	Olwer's tract,	12 ft. seam,		79.08	16.28	4.64
Maryland,	Nr. Westernport,	Sigler's mine,		82.60	15.76	2.64
"	Lonaconing,	12 ft. seam,		77.43	19.37	3.20
	Abraham's cr.	Macdonald's 3d seam,		74.00	18.60	7.40
	1 mile from top of Alleghany,	Nr. Turnpike,		77.12	19.60	3.28
	Vandover's	N. W. Turnpike,		61.44	14.28	24.28
Hardy,	Kitzmiller's,			79.76	15.48	4.76
"	Falls of Stony river,	Lower seam,		79.16	15.52	5.32
	Abraham's cr.	Michael's,		72.40	15.20	12.40
	Stony river,	N. of Turnpike,		83.36	13.28	3.36
	Michael's,	Upper part,		45.24	14.96	39.80

County.	Locality.	Designation of coal beds.	By whom analysed.	Analysis. Carbon.	Volatile matter.	Ashes.
Western Virginia. Preston and Mongalia Counties,—Basins containing the Lower Coal Series.						
Preston,	Kingswood,	Fairfax's,	State reports,	53.77	31.75	14.48
"	"	Middle seam,		65.32	27.77	6.91
"	"	Forman's basin,		73.68	21.00	5.32
"	Deck Hollow, c.	Martin's,		65.42	23.42	11.16
"	Buffalo Lech run,	Beatty's		62.56	29.60	7.84
"	Big Sandy,	N. Brandon's,		67.60	22.40	10.00
"	N. Brandonv'le,	Morton's,		65.28	30.80	3.92
"	Cheat river, n. Kingswood,	Price's,		60.36	25.00	14.64
"	Big Sandy, W. side,	Seaport's,		66.64	27.12	6.24
"	Kingswood,	Hagan's,		68.32	26.48	5.20
"	"			67.28	29.68	3.04
"	Big Sandy basin,	W. side Cheat,		60.04	26.88	13.08
"	Kingswood,	Cresaps,		64.24	30.24	5.32
Bituminous Coals in Eastern Virginia, in the Chesterfield, Powhatan, Goochland, and Henrico Basins.						
South side James river, 1	Stonehenge,	Chesterfield,		58.70	36.50	4.80
Chesterfield, 2	Maidenhead,	Engine shaft,		63.97	32.83	3.20
" 3	Heth's pit,	"		62,35	37.65	2.80
" 4	Mill's & Reid's,	Creek pit,		57.80	38.60	3.60
" 5	Will's pit,			62.90	32.50	4.60
" 6		Green hole sh't,		67.83	30.17	2.00
" 7	Heth's deep shaft,	Bottom seam,		53.36	35.82	10.82
"	"	Middle seam,		66.50	28.40	5.10
"	"	Top seam,		61.68	28.80	9.52
" 8	Powhatan pits,	Finney,		59.87	32.33	7.80
" 9	Winterpock ck.	Cox's mine,		65.52	29.12	5.36
	Cloverhill, Appomattox R.	Slate coal,	G. W. Andrews, M. D.	55.00	38.50	6.50
	"	Mean of 4 spec.	Johnson,	54.83	33.04	10.13
	Richmond coal,		Andrews,	59.25	32.00	8.75
	Mid Lothian,	Wooldridge's p.	Johnson,	61.08	28.45	10.47
	"	Mean result, av. size coal,	"	53.01	33.25	14.74
	Creek Coal Co.	Mean of 6 trials,	"	60.30	31.13	8.57
	Bl'k Heath pits,	Mean of 4 spec.	"	58.79	32.57	8.64
	Tippecanoe p's,	do.	"	54.62	36.01	9.37
North side of James R 10		Randolph's,	W. B. Rogers, State report,	66.15	30.50	3.35
11	Coalbrook dale,	Second seam,	"	66.48	29.00	4.52
12	Anderson's pit,	First seam,	"	66.78	28.30	4.92
13	Barr's pits,	"	"	70.80	24.00	5.20
14	"	Second seam,	"	54.97	22.83	22.20
15	"	Third seam,	"	65.50	24.70	9.80
16	"	Fourth seam,	"	56.07	21.33	22.60
17	Crouch's Lower shaft,	Upper s'm, 110 ft. from surface,	"	64.60	30.00	5.40
	"	Mean of 4 spec.	Johnson, State report,	67.32	23.96	8.72
18	Scott's pit,			60.86	33.70	5.44
19	Waterloo shaft,		"	55.20	26.80	18.00
20	Deep Run pits,		"	69.84	25.16	5.00
	"	Mean of 40 sp.	"	67.96	21.57	10.47
	Wills's pit,	Upper vein,	T. G. Clemson	66.60	28.80	4.60
	Anderson's pit,	Bottom seam,	R. C. Taylor.	64.20	26.00	9.80
	Chesterfield,	Called natural coke,	W. B. Rogers, State report,	80.30	9.98	9.72
	"	"	"	70.00	16.00	14.00
	"	"	Prof. Bailey,	68.00	17.00	15.00
	"	Mineral charc'l.	T. G. Clemson,	83.30	10.70	6.00

Semi-bituminous or dry Coals in the State of Maryland.—The Cumberland or Frostburg Coal region, occupyiug a small part of Pennsylvania.

State and County.	Locality.	Designation of Coal Beds.	By whom analysed.	Specific gravity.	Analysis. Carbon.	Volatile matter.	Ashes.
PENNSYLVANIA. Somerset,		1. Hoyman's new eight foot bed,	W. R. Johnson,	1.343	69.90	22.00	8.10
do.		2. Uhl's up. vein,	do.	1.319	75.75	20.20	4.05
do.		3. Korn's	do.	1.386	68.46	20.10	11.44
do.		4. Schaeffer's	do.	1.370	70.70	18.80	10.50
do.		5. Hoyman's 8 ft. as above,	do.	1.363	71.50	18.30	10.20
do.		6. Hoyman's 6 ft.	do.	1.362	68.54	19.80	11.66
do.		7. Uhl's 7 ft. vein,	do.	1.388	68.44	19.50	12.06
do.		8. Weller's 4 feet,	do.	1.321	69.10	19.99	11.00
do.		9. Church land vein,	do.	1.480	68.56	18.70	12.74
do.		10. Hardin's vein,	do.	1.491	66.36	17.60	16.04
		Mean results of the ten veins,		1.382	69.73	19.59	10.68
MARYLAND.							
Alleghany,	Maryland company,	Hoffman's mine, on main seam,	Silliman and Shepard,	1.380	82.01	15.00	2.99
do.	Cumb'd coal,	do.	W. Hayes, (Boston,)		77.86	15.60	6.54
do.	Savage river,	do.	Dr. Jones, (Washington,)		78.00	19.00	3.00
do.	do.	do.	D. Jackson, (Boston,)	1.321	77.09	16.05	7.06
do.	Maryl. comp.	do.	Dr. T. P. Jones, (Washington,)	1.291	72.50	22.50	5.00
do.	do.	do.	do.	1.333	81.00	15.00	4.00
do.	do.	Frost's mine,	Dr. Ducatel,		70.00	20.50	9.50
do.	Dan's mount.	Av. of 40 specim.	Johnson,	1.311	73.59	16.04	10.37
do.	Cumb'd coal,		Prof. Daniel,		66.30	19.40	14.30
do.	do.	Maryland comp'y,	Johnson,	1.431	67.26	14.42	18.32
do.	do.	Frostburg Neff's,	do.	1.332	74.53	15.13	10.34
do.	do.	Howell's estate,	Silliman,		76.77	14.66	8.57
	do.	do.	Prof. Renwick,		81.00	13.00	6.00
do.	do.	Easby's	Johnson,	1.305	77.25	16.23	6.52
do.	George's creek,	Main vein, Lonaconing,	Dr. Ducatel,	1.386	79.25		
do.	do.	Third coal,	do.	1.552	80.08		
do.	do.	Fourth coal,	do.	1.584	85.00		
do.	Lonaconing company,	George's creek, thick bed,	Johnson,	1.346	70.75	16.03	13.22
do.	Maryland company,	Eckert mine on main seam,	do.	1.437	68.56	15.62	15.82
do.	Frostburg,		Chilton,		77.00	12,00	11.00
do.	do.	Mean of 2 analys.	Dr. J. Percy,		78.80	9.47	11.73

Fat, bituminous Coals in the State of Ohio.

County.	Locality.	Designation of Coal Beds.	By whom analysed.	Specific gravity.	Analysis. Carbon.	Volatile matter.	Ashes.
Portland,	Talmadge,	Upson's mine	W. W. Mather,	1.264	53.404	44.298	2.288
Jackson,	Lick Township,		do.	1.283	49.882	47.327	2.221
do.	Madison Town.		J. L. Cassels,	1.560	39.950	44.800	14.620
do.	do.	Cannel coal,	do.	1.410			
	Carr's Run,		R. C. T.	1.270			
	Pomeroy,		Dr. J. Percy,		76.70	18.70	4.60

Fat, bituminous Coals in Pennsylvania.

County.	Locality.	Names of Coal Seams.	By whom analysed.	Specific gravity.	Analysis. Carbon.	Volatile matter.	Ashes.
Venango,	Shippensville,	Sandy Ridge,	H. D. Rogers' State Report,		49.80	43.20	7.00
do.	6. M. F. of Franklin,		do.		29.54	52.78	17.68
Beaver,	Greersburg,		do.		30.12	36.00	33.88
Crawford,	Conneaut Lake,		do.		59.45	38.75	1.80
Mercer,	Greensville,		do.		57.80	40.50	1.70
	do.		R. C. T.	1.275			
	Orangeville,		State Report,		53.45	43.75	2.80

Moderately bituminous, dry, and close burning Coals in Pennsylvania.

County or District.	Locality.	Designation of Coal Beds.	By whom analysed.	Specific gravity.	Analysis. Carbon.	Volatile matter.	Ashes.
Tioga or Blossburg Coal-field.	Blossburg,	Coal Run, Upper Vein,	Taylor and Clemson,	1.371	75.40	16.40	8.20
	do. Bear cr'k,	Clement's Coal,	do.	1.398	73.74	15.00	11.26
	do.	Bloss' Coal,	do.	1.405	73.00	15.60	11.40
	do.	do.	State Report,		62.80	32.80	5.20
	do. Johnson's Run,	Splint Coal,	Taylor and Clemson,	1.493	69.30	14.60	16.10
	do. Coal Run,	Slaty variety called Cannel,	do.	1.750	33.40	8.40	58.20
	do. do.	Pitch Coal,	do.	1.500	54.26	18.50	27.24
	Head of Tioga,	New Hope Vein,	R. C. T.	1.429			
	Arbon company,	Coal run, mean of 4 specim.	Johnson,	1.323	73.11	16.12	10.77
Ralston and Lycoming Creek Distr.	Ralston,	Big Vein,	State Report,		74.50	20.50	5.00
	do.	do.	Johnson,	1.387	71.54	14.50	13.96
	Queen's Run,	Av. of 40 speci.	do.	1.331	73.44	18.81	7.75
	do.		State Report.		73.68	21.50	4.60
Bradford or Towanda Coal-field.	Schrœder, branch of Towanda creek,	Lower Bed in three parts,	W. R. Johnson,	1.515	62.60	15.00	22.40
				1.448	70.00	17.40	12.60
				1.465	63.90	19.10	17.00
	do.	Miller's Old Coal Drift,	do.	1.377	68.10	20.50	11.40
				1.378	65.50	19.20	15.30
				1.349	74.97	19.30	5.73
	do.	Mason's coal, upper part,	do.	1.388			
		lower part,		1.400			
Centre Co.	Snow-shoe,		State Report,		76.73	21.20	2.07
do.	Farrandsville,	Select port'n of Diamond Vein,	Bache and Rogers,	1.339			5.50
do.	Lick Run,		State Report,		66.21	20.72	13.07
Clearfield Co.	Karthaus,		W. R. Johnson,	1.263	68.15	26.80	5.05
do.	do.	Salt Lick,	do.	1.292	80.49	12.83	6.68
				1.275	76.64	22.27	5.09
do.	do.	Upper Seam,	State Report,		78.20	13.00	8.80
do.	do.	Lower Seam,	do.		70.50	24.80	4.70
do.	Curwensville,	Reed's Vein,	do.		67.70	27.00	5.30
do.	Caledonia,		do.		54.50	37.00	8.50
do.	do.		do.		54.60	38.20	2.70

Moderately bituminous, dry, and close burning Coals in Pennsylvania.—(Continued.)

County or District.	Locality.	Designation of Coal Beds.	By whom analysed.	Specific gravity.	Analysis. Carbon.	Volatile matter.	Ashes.
Moshannon district.							
	Karthaus,	Main or 6 ft. sm.	W. R. Johnson,		68.15	26.80	5.05
	Philipsburg,	Best coal,	W. R. Johnson and R. C. T.	1.308	70.00	22.30	7.70
	"	"	State Report,		64.40	29.50	6.10
	"	"	Dr. Goddard,	1.360	70.00	20.00	10.00
	near "	Showalter's 3 ft. Vein,	R. C. T.	1.358			
	" "	Goss's 6 ft. Vn.	"	1.357			
	" "	Coal hill,	"	1.500			
	16 miles,	Steed's mine,	State Report,		68.40	20.40	11.20
	17½	Leech's mine,	"		67.93	20.32	11.75
Cambria,	Blair's Gap,	Portage Rail R.	T. G. Clemson,		77.00	15.00	8.00
"	"	Mineral charc'l,	"		66.40	6.60	27.00
"	"	Large bed,	State Report,		65.00	31.00	4.00
"	Summit,	Portage Rail R.	Johnson,	1.406	69.59	21.36	9.05
Semi-bituminous Coals in Pennsylvania.							
Dauphin,	Short M'n.	South drift,	Dr. Ellet, R. C. T.	1.330	75.50	15.30	9.20
		Big Flat's Vein,	J. C. Booth,			16.90	
"	"		M. C. Lea,		71.20	17.32	13.46
			R. C. T.	1.395			
			Rogers' reports,		76.94	15.06	8.00
		Perseverance Vein,	J. C. Booth,			15.80	
			M. C. Lea,	1.391	78.80	13.20	8.00
"	Rattling Run Gap,		"		76.10	16.90	7.00
			Rogers' reports,		74.55	13.75	11.70
			Johnson, mean of 6 exp's,	1.531	72.22	14.29	11.49
Lebanon,	Yellow Springs,	Back bone vein,	H. C. Lea,	1.389	74.70	14.80	10.50
		Kugler vein,	J. C. Booth,			8.10	
			M. C. Lea,	1.391	80.33	8.86	10.80
"	"		"		81.20	9.80	9.00
			"	1.395	77.50	11.00	11.50
			Rogers' reports,	1.410	79.55	10.95	9.50
"	Cold Spring,	Six feet vein,	H. Lea,	1.403	76.30	11.10	12.60
Bedford,	Broad Top m.	Riddle's bank,	Clemson,	1.700	70.10	16.70	13.20
"	"	Hopewell,	Rogers' reports,		84.80	11.20	4.00
"	"		W. R. Johnson,		77.60	16.00	6.40
Soft, free burning Red Ash Anthracite in Pennsylvania. Coal seams of the South Mn.							
Dauphin,	Lyken's Valley,	Bear Gap mines,	R. C. Taylor,	1.318			
"	"	1st sample,	W. R. Johnson,	1.391	87.95	7.60	4.45
"	"	2d,	"	1.404	89.30	5.95	4.75
"	"	3d,	"	1.416	85.70	10.00	4.30
"	"	4th,	"	1.374	88.70	4.60	6.70
"	"	5th,	"	1.376	87.75	8.35	3.90
"	"	6th,	"	1.395	88.65	8.30	3.05
"	"	7th,	"	1.382	87.20	7.84	4.15
"	"	8th,	"	1.398	83.99	11.85	4.15
"	"	9th,	"	1.378	87.00	7.30	5.70
"	"	mean of 9 s'pls,	"	1.390	87.36	8.06	4.57
"	"	Third Bed,	H. D. Rogers' Report,		88.25	8.85	2.90
Schuylkill,	Lower Mohantongo,	Klinger's or Rausch Gap,	J. R. Chilton, M. D.		89.71	4.48	5.81

Anthracite of Pennsylvania.

Group	Description and Localities of Anthracite Coal Beds. Hard, White Ash Coal.	By whom examined or analysed.	Specific gravity.	Analysis of 100 parts of Anthracite. Carbon.	Water, hydro. and volatile matter.	Ashes, silica, earthy matter, iron, &c.
Schuylkill Eastern Region.	Mauch Chunk,	Olmsted,	1.550	90.10	6.60	3.30
	"	Vanuxum,	1 494			
	" Summit Mines,	W. R. Johnson,		92 30	6.42	1.28
	" "	Karsten,		86.00	8.00	6.00
	" "	M. C. Lea,		87.00	7.30	5.70
	" 14 feet Vein,	Rogers's Reports,		88.50	7.50	4.00
	" Hardest Variety,	"		87.70	6.60	5.70
	" mean of 2 results.	Dr. J. Percy,		92.60	5.15	2.25
	Nesquehoning,	Taylor,	1.558			
	" 10 feet Vein,	Rogers's Reports,		86 60	6.40	7.00
	Tamaqua Vein, D east,	M. C. Lea,		91.00	5.50	3 50
	" D. "	Rogers's Reports.	1.570	92.07	5.03	2.90
	" E. "	"	1.600	89.20	4.54	6.26
	" R.	"	1.550	87.45	7.55	5.10
	Tuscarora,	"		88.20	7.50	4.30
	Forest Improvement, av. of 4 specim.	Johnson,	1,477	92.12	4.83	3.05
Middle Coal-field.	Hazleton,	Tayor,	1.550			
	Sugar loaf Mountain,	W. R. Johnson, 3 Samples.	1.591	88.18	6.99	4.83
			1.574	85.91	5.36	8.73
			1.550	90.70	7.06	2.24
	Beaver Meadow,	Taylor,	1.600			
	"	W. R. Johnson,	1.630	85.34	9.60	5.06
	"	"	1.560	91.64	6.89	1.47
	"	"		92.30	6.42	1.28
	Girardville,	Taylor,	1.600			
	Broad Mountain, W. W. Branch,	"	1.700			
Pine Grove District. Red ash c'l.	Big Vein, Lorberry Creek,	"	1.472			
	" "	M. C. Lea,		85.90	7.20	6.90
	Sharp Mountain,	Rogers's Reports,	1.540	80,57	7.15	3.28
Red Ash.—Free burning coal, with slight flame. *Stony Creek Estate, Lebanon Co. First Coal-field.*	Black Spring Gap, 4 feet Vein,	Taylor,	1.528			
	" "	Rogers's Reports,	1.440	82 47	9.53	8.00
	" Peacock Vein,	Taylor & M. C. Lea		88.60	7.10	4.30
	" Grey Vein,	M. C. Lea and Taylor,	1.379 1.395	86.00	4.50	9.50
	" The black compact part,	Rogers's Reports,	1.440	81.02	9.78	9.20
	" The Grey central part,	"	1.330	81.40	11.40	7.20
	" Fishback Vein,	M. C. Lea,		84.00	6.50	9.50
	" Lea Vein,	Rogers's Reports,	1.350	85 84	8.96	5.20
	Gold Mine Gap, Peacock Vein,	M. C. Lea,		83.0	9.0	8.0
	" "	Rogers's Reports,	1.410	83.15	10.95	6.90
	" Heister Vein,	"	1.410	81.47	10.43	8 10
	Rausch Gap,	M. C. Lea,		78.90	11.00	10.10
	" Pitch Vein,	R. C. Taylor,	1.387			
		"	1.454			
	" Heister Vein,	M. C. Lea,		77.10	10.90	12.00
		Rogers's Reports,	1.450	77.23	10.57	12.30
White Ash Coal. *South and Mid. Coal-field.*	Broad Mountain,	Dr. C. T. Jackson,	1.593			7.80
	Lehigh or Summit Company, 1st,	W. R. Johnson,	1.613	87.48	7.51	5.01
	" " 2d,	"	1.594	91.69	4 31	4.00
	" " 5th,	"	1.612	86.06	9.23	3.71
	Mauch Chunk,	Dr. J. Percy,		84.98	4.82	10.20
	Buck Mountain,	W. R. Johnson,	1.559	91.02	5.90	3.08
	Shamokin, (Snyder's)	Rogers's Reports,		89.90	6.10	4.00
	West Mahanoy,	Taylor,	1.371			
North or Wyoming Coal-field.	Wilkesbarre, Blacksmith's coal,	do.	1.472			
	" Warden's Vein,	Rogers's Reports,	1.403	88.90	7.68	3.49
	Wyoming,	J. F. Frazer,		91.20	4.50	4.30
	Lackawanna,	Dr. C. T. Jackson,	1.609	79.20	9.20	11.60
	" mean result,	Johnson,	1.421	88.98	6.36	4 66
	Carbondale,	Rogers's Reports,	1.404	90.23	7.07	2.70
Red Ash Coal. *Pottsville District. First or South Coal-field.*	Peach Mountain, Delaware Co.	Taylor,	1.446			
	" mean of 40 specim.	Johnson,	1.464	86.09	6.96	6.95
	" N. American Co.	Dr. C. T. Jackson,	1.569			7.20
	Peach Orchard,	"	1.532			6.60
	Salem Vein,	Taylor,	1,574			
	Plumbago Vein, Sharp Mount.	"	1.412			
	Black Mine Vein,	H. Lea,		88.40	6.80	4.80
	Gate Vein,	Dr. C. T. Jackson,	1.609			6.60
	Shenoweth Vein,	Rogers's Reports.	1.500	94 10	1.40	4.50
	Nealey's Tunnel, 3d Vein,	"	1.550	89.20	5.40	5.40

Anthracites of the United States.

Description of Coal beds.		Details.		Analysis of 100 parts of anthracite.		
State.	Locality of Mines.	By whom examined or analysed.	Specific gra'ty.	Carbon.	Water, hydrogen and volatile matt'r.	Ashes, silica, earthy matter, iron, &c.
Rhode Island,	Portsmouth mines,	Dr. C. T. Jackson,	1.850	85.84	10.50	3.66
	" "	"		87.50	7.00	5.50
	" "	"		77.50	13.00	9.50
	" "	"	1.770	84.50	10.00	5.50
	" "	L. Vanuxem,		90.03	4.90	5.07
	" "	"*		77.70	6.70	15.60
	Cumberland "	Dr. C. T. Jackson,		77.00	7.60	15 40
	" "	"		39.70	7.80	52.10
	Providence "	"		72.00		28.00
	Portsmouth old mine,	"		74 00	10.00	16.00
	Case's mine,	"		97.00		3.00
Massachusetts,	Mansfield mine,	Dr. C. T. Jackson,	1.690	87.40	6.20	6 40
	" "	"	1 780	92.00	6.00	2.00
	" "	"	1.710	92.00	6.00	2.00
	Worcester, plumbaginous anthr'e,	Dr. J. Percy,		28.35	3.08	68.57
North Carolina,	Near Leakesville, middle secondary rocks,	W. B. Rogers,		83.12	7.76	9.12
* England,	Borrowdale, Plumbago.	L. Vanuxem,		83 37	1.23	10.40
* Pennsylvania,	Bustletown, Plumbago.	"		94.40	.60	5.00
* England,	Cornwall, Plumbago.	Saussure,		96.00		4.00

Bituminous Coals.

State and county.	Locality.	Designation of coal beds.	By whom analysed.	Spec. gravity.	Analysis.		
					Carbon.	Volatile matter.	Ashes.
INDIANA.							
Parke county,	Sugar creek,	Foundry,	D. D. Owen,	1.219	75 00	21.00	4.00
Vermilion,	Brouillet's cr.		"	1.270	52.00	39.00	9.00
Vigo,	Honey creek.		"	1.240	70.00	27.50	2.50
Sullivan,	Busseron,	Lick fork,	"	1.240	70.00	28 00	2 00
Fountain,	Wabash,	Coal creek mouth,	"	1.260	60 00	25.00	15.00
Spencer,	Anderson creek,		"	1.270	45.00		
	White river,		"	1.270	56.40		
	Terre Haute,		"	1.240	50.80		
	Cannelton,	Cannel coal,	W. R. Johnson,	1.272	59.47	36.59	3.94
ILLINOIS.	Rock river,	Coal,	Dr. D. D. Owen,	1.340	45.50	44.50	10 00
	Vermilion,	Danville,	A. Morfit,		48.50	47.20	4.30
	Western port,		Johnson,	1.290		32.80	
	Ottowa,		J. F. Frazer,		62.60	35.50	1.90
	Rockwell,		C. U. Sheppard,	1.273	46.50	47.50	6.00
IOWA.	Duck creek,	W. bank of the Mississippi R.	Dr. D. D. Owen,	1.270	48.50	44.00	7.50
MISSOURI.	Cote-sans dessein, Callaway co.	Mastodon vein, forty-six feet thick,	Booth and Boye,		46.83	40.05	13.12
			J. R. Chilton, M. D.	1.252	50.81	34.06	15.13
		Mammoth vein, twenty-four ft.	"	1.250	50.78	34.20	15.02
	Osage river,		W. R. Johnson,	1.200	51.16	43.50	5.34
ARKANSAS.	Johnson county,	Spaldre's bluff,	J. F. Frazer,	1.396	62.60	28.90	8.50
MAINE.		Peat,	Dr. Jackson,		21.00	72.00	7.00
Miscellaneous Analysis.							
Isle of Cuba,	Nr. Havana,	Asphalt.	T. G. Clemson,	1.190	34.97	63.00	2.03
	Nr. Matanzas,	Asphaltum,	"				13.50
S. America,	Peru,	Coxitambo.	M. Bousingault,				
	Chili,	Arauco,	W. R. Johnson,	1.324	67.62	30.00	2.38
	Brazil,		Karsten,	1.289	57.90	40.50	1.60
	"		"	1.483	38.10	33.50	28.40
Madeira Island,	Brown coal,	Or lignite,	Johnstone,				20.05
British America Bitum's Coal.							
Nova Scotia,	Pictou,	Cunard's sample,	Johnson,	1.325	60.73	26.76	12.51
		Mining Associa'n,	"	1.318	56.98	29.63	13.39
Cape Breton,	Sydney,	Mean of 2 species,	"	1.338	67.57	26.93	5.50

* Mr. Vanuxem adds, by way of comparison, the analysis of three varieties of plumbago or graphite.

EUROPE.

Fat, bituminous Coals of England and Scotland.

Description and Locality of Veins.	By whom analysed and described.	Specific gravity.	Analysis of 100 parts of Coal.		
			Carbon.	Bitumen, volatile matter and water.	Ashes and cinders.
Alfreton, Furnace Coal,	D. Mushet,	1.235	52.46	45.50	2.04
Butterley, " Derbyshire,	"	1.264	52.88	42.83	4.29
Derbyshire, Cannel Coal, Alfreton,	"	1.278	48.36	47.00	4.64
Wigan, Cannel Coal,	Dr. Thomson,		52.60	44.00	3.40
"	Kerwan,	1.272	75.20	21.68	3.10
"	R. C. T.	1.275	61.73		
Lancashire, Cannel Coal,	Dunn,		56.40	41.00	2.60
Woodhall n'r Glasgow, Cannel Coal,	Dr. Ure,	1.228			
Liverpool Coal,	Johnson,	1.260	54.90	40.48	4.62

Fat, bituminous adhesive Coal—coked previously to using in the Furnace.

Description and Locality of Veins.	By whom analysed and described.	Specific gravity.	Analysis of 100 parts of Coal.		
			Carbon.	Bitumen, volatile matter and water.	Ashes and cinders.
Newcastle upon Tyne Birtley Works,	Dufrenoy and Berthier,	1.270	60.50	35.50	4.00
"	Thomson,		65.90	32.60	1.50
"	Karsten,	1.256	67.65	31.50	0.85
Northumberland, Tyne Works,	Dufrenoy and Berthier,		67.50	30.00	2.50
Staffordshire, Apdale Works,	"		62.40	34.10	3.50
Redesale, Newcastle, N. of the Tyne,	M. Dunn,		49.95	51.00	3.05
Wylam,	"		48.49	37.60	13.91
Garesfield and Auckland,	"		72.71	25.90	1.39
Newcastle Coal, (mean)	W. R. Johnson,	1.257	57.00	37.60	5.40

Bituminous Coal—used crude in the Hot Air Furnace.

Description and Locality of Veins.	By whom analysed and described.	Analysis of 100 parts of Coal.		
		Carbon.	Bitumen, volatile matter and water.	Ashes and cinders.
Staffordshire, Tipton, Wednesbury Coal works,	Berthier,	67.50	30.00	2.50
Derbyshire, Butterley, Cherry Coal,	"	57.00	40,00	3.00
" Dodnor Park, Soft Coal,	"	51.50	45.50	3.00
Soft or mixed English,	D. Mushet,	53.00		

Bituminous and Semi-bituminous Coals of South Wales, on the eastern side the Coal Basin.

Description and Locality of coal-beds.		Thickness of each bed.	Anal. of 100 parts coal, by Mushet.			The Coal described and its uses.
		ft. in.	Carbon.	Bitu'n, vol. matter, &c.	Ashes or cinders.	
Abersychan,	Meadow vein,	8 6	65.98	29.40	4.62	thin laminæ, furnaces.
	Old coal,	2 6	71.10	27.40	2.50	laminæ, "
Golynos Iron works,	Three quarter,	5 6	71.88	25.50	2.62	"
	Rock vein,	7 0	69.60	27.40	3.00	thin laminæ, run out fires.
	Meadow vein,	7 0	68.00	27.50	4.53	dense, furnaces.
	Old coal,	2 4	73.40	20.60	6.00	laminæ, "
Verteg Iron works. Furnace coal,	Red vein,	4 0	69.45	26.30	4.25	" "
	Big vein,	4 0	66.05	30.70	3.25	irreg'ly laminated, "
	Droydeg or rock vein,	4 0	64.45	32.30	3.25	oblong, forge and mill.
	Three quarter,	5 6	67.90	29.60	2.50	rather friable, furnace.
	Meadow vein,	7 0	69.25	30.50	9.25	thin laminæ, "
Blaenafon Iron works,	Three quarter,	5 6	65.63	31.25	3.12	" "
	Droydeg or rock vein,	5 6	65.55	28.95	5.50	cubical, refineries.
	Meadow vein,	2 10	72.00	26.00	2.00	furnace.
	Old coal,	6 0	75.21	22.29	2.50	laminated, "
Clydach or Llanelly Iron works,	Red vein,	3 0	76.58	20.80	1.62	forge and mill.
	Big vein,	5 0	73.42	24.58	2.00	thin layers, "
	Three quarter,	2 9	72.70	25.30	2.00	broad, "
	Droydeg or rock vein,	7 0	72.13	21.87	6.00	cubical, "
	Tach coal,	3 0	70.05	25.57	4.38	cones, household.
	Yard vein,	2 9	78.68	19.32	2.00	hard, furnaces.
	Old coal,	5 6	77.55	18.95	3.50	alternating lamina, "
Nant-y-glo Iron works,	Elled coal,	3 6	81.87	17.13	1.00	lamellar, "
	Three quarter,		82.65	15.10	2.25	coking for the refineries.
	Droydeg vein,		77.14	17.86	5.00	twisted, forges and mills.
	Old coal,	5 6	78.75	18.75	2.50	imperfect, furnaces.
Sirhowey Iron works,	Ell coal,		82.04	16.71	1.25	sectional, "
	Three quarter,		83.50	12.00	4.30	with numerous partings.
	Big vein,	8 0	81.52	15.10	3.38	rhomboidal, furnace.
	Mudelog v'n or droydeg,		80.50	11.87	7.63	partially granulated.
	Yard coal,		82.24	15.88	1.88	twisted, with clod.
	Engine coal,	4 0	82.46	15.41	2.13	irreg'ly granular, furnaces.
	Three quarter engine,		75.78	13.22	11.00	hard.
	Old coal,	4 0	78.50	13.00	8.50	conchoidal partings.
Ebbw Vale Iron works,	Yard coal,	3 2	81.04	15.83	3.13	friable, forges and mills.
	Three quarter,	3 0	80.25	17.00	2.75	cubical, blast furnaces.
	Big vein,	4 8	81.37	17.00	1.63	cubical, " and forges.
	Bydelog or droydeg,	2 10	72.88	16.87	10.25	coarse, " "
	Ell coal,	3 2	82.32	16.30	1.38	granular, " "
	Old coal, top,	5 6	79.28	18.22	2.50	cubical, forge and mill,
	" bottom,		81.77	15.73	2.50	less granular, blast fur'ce.
Beaufort,	Old coal,	4 6	76.82	20.80	2.38	cubical, fur'ce and refi'ry.
Pont-y-mister,	Forge coal,		75.06	22.22	2.72	cubical, furnace and forge.
Blaina,	Big vein,	5 6	72.14	25.86	2.00	granular, "
	Three quarter,	5 6	77.38	21.12	1.50	cubical, "
Tredegar Iron works,	Big vein. top,	3 0	80.45	16.55	3.00	compact, blast furnace.
	" lower part,	3 0	81.56	14.94	3.50	very compact, "
	Red vein, upper part,	1 0	79.44	14.06	6.50	laminated.
	" under part,	3 0	80.26	18.49	1.25	reedy laminæ, blast fur'ce.
	Bydelog, (droydeg)	3 0	78.90	17.97	3.13	fine laminæ, forge.
	Yard vein,		82.26	15.36	2.38	reedy lamina, blast fur'ce.
	Penmark vein,		80.11	14.06	5.83	reedy, forges and mills.
	Three quarter,		80.20	13.80	6.00	laminæ with clod.
	Engine coal or old coal,	5 6	77.30	15.20	7.50	reedy.
Rhymney Iron works,	Big vein, upper part,		81.26	16.24	2.50	partially reedy, blast fur'e.
	" lower part,		82.33	13.17	4.50	strong, "
	Raslas vein,	7 0	82.79	12.96	4.25	reedy, "
	Brassy vein,	1 3	83.38	14.37	2.25	twisted, workmen's fires.
	Red coal,	3 6	84.25	12.75	3.00	granular, furnaces.
	Yard coal,		80.92	16.20	2.88	irregular, "
	Four feet coal,		80.15	15.10	4.75	irreg'r l'ina, forges & mills.
	Fire clay coal,	1 0	80.60	17.40	2.00	reedy.
	Black vein,	2 6	82.51	14.99	2.50	" forge.

Semi-bituminous or steam Coals of South Wales.

	Description and Locality Of Coal-beds.		Thickness of each vein. ft.	in.	Analysis of 100 parts of coal, by D. Mushet. Carbon.	Bitu'n. vol. matter, water, &c.	Ashes or cinders.	The Coal described, and its uses.
On the northern side of the Coal Basin.	Bute Iron works.	Red vein,	4	0	83.04	14.58	2.38	thin laminæ.
		Big vein,	9	0	83.53	13.74	2.73	"
		Raslas vein,	9	0	84.06	12.44	3.50	"
		Four feet vein,	4	0	78.30	16.45	5.25	in compact, forges.
	Dowlais Iron works.	Big v. upper pt.			80.88	15.62	3.50	reedy, blast furnaces.
		Middle part,	11	0	85.00	11.87	3.13	thin layers, brittle.
		Bottom part,			82.81	13.44	3.75	irregular, shining.
		Raslas vein,						
		Upper part,	9	0	84.08	13.02	2.90	imperfect cleavage.
		Lower part,			85.02	13.23	1.75	strong, laminæ thin.
		Upper four feet,	4	0	85.75	12.75	1.50	prisms, furnace coal.
		Lower four feet,	4	0	85.35	12 40	2.25	shining laminæ.
		Cwmcenol,	2	9	88.63	9.74	1.63	in layers, furnace coal.
		Four feet forge,	5	0	88.78	7.97	3.25	part reedy, forge coal.
		Little vein,	3	0	86.90	11.72	1.38	thin laminæ, forges.
	Pen-y-darren Iron works.	Foes-y-frane,	7	0	85.04	11.46	3.50	compact, blast furnaces.
		Raslas,	7	0	87.69	10.31	2.00	incompact, "
		Three feet coal,	3	0	85.07	12.18	2.75	broad, "
		Four feet coal,	4	0	88.50	10.00	1.50	hard, "
		Upper vein,	3	6	86.08	10.42	3.50	" forges and mills.
		Roof-pin vein,	2	0	83.30	11 20	5.50	" mixed quality.
		Big vein,			86 01	12.24	1 75	crystallized, with clod.
		Bottom coal,	4	0	87.20	11.30	1.50	compact, forges.
	Plymouth and Duffryn Iron works.	Upper or yard c'l,	3	9	79.06	15.34	5.60	mixed, "
		Four feet coal,	4	0	84.98	11.77	3 25	" less shining.
		Clynmil c'l, top p.	3	6	86.62	12.00	1.38	conical, best furnace c'l.
		" bottom,	4	6	85.48	12.39	2.13	granular, blast furnaces.
		Raslas, top part,	4	6	82.05	13.95	4.00	bright, "
		" bottom pt	3	6	83.84	13 33	2.83	both reedy and granular.
		Upper Dingle c'l,	3	6	77.00	20.00	3.00	broad, forges and mills.
		Lower Dingle,	2	6	80.34	16.66	3.00	less bright and shining.
	Cyfarthfa and Ynnis Vach Merthyr Iron works.	Cyfarthfa big vein,	9	0	90.28	7.97	1 75	slightly reedy.
		Cwm-dhu pit,	6	0	88.78	9.22	2.00	regularly laminated.
		Cwm-mynedd,	5	6	88.87	9.00	2.13	slaty, forges and mills.
		Cwm-y-glo,	4	0	89.29	6.58	4.13	incompact, blast furn'cs.
		Upper yard vein,	3	0	86.80	11.20	2.00	regular, "
		Gelly-deg,	3	0	91.86	6.14	2.00	specular, forges.
		Mountain vein,	3	6	90.02	8.48	1.50	crystallized, furnaces.
		" ironstone,	1	6	92.11	6.14	1.75	reedy and granular.
	Aberdare Iron works.	Four feet coal,	4	0	87.00	11.50	1.50	compact, blast furnaces.
		Raslas vein,	10	0	88.89	9.11	2.00	" forges.
		Two feet coal,	2	0	88.12	10.00	1.88	mixed reedy and gran'lr.
		Small vein,	5	6	80.42	10.83	8.75	compact, refineries.
		Foes-y-frane,	4	0	84.67	8.33	7 00	" furnaces.
		Two ft. 9 inch c'l,	2	9	88.51	9.99	1.50	bright reedy coal.
		Yard vein,			82.99	14.26	2.75	reedy, furnaces.
		Black mine coal,			91.18	6.82	2.00	bright reeded coal.
		Upper vein,			82.12	12.13	5.75	granular, with clod.
	Hirwain Iron works.	Big vein,	9	0	88.94	7.18	3.88	crystallized, forges.
		Four feet coal, or Glo-wynn,	4	0	90.26	7.86	1.88	slightly reedy, furnaces.
		Six feet coal,	6	0	89.96	8.04	2.00	regular reeded, forges.
		Pit vein,	3	0	87.15	8.85	4.00	reedy and granular.
South side the Coal Basin.	Argoed in Cwm Buchan.	Upper vein,	3	0	76.54	22.50	0.96	friable, weak.
		Lower vein,	3	0	74.30	23.40	2.30	harder, more compact.
	Oakwood, Glamorgansh. second coal series.	Wern Dhu,	2	3	78.02	20.18	1.80	used for smelting iron.
		Wern Pistill,	2	6	80.06	17.46	2.48	hard, compact.
		Rider vein,			80.67	18 52	0.81	second coal series.
		Tor Mynydd,	1	8	81.18	18.00	0.82	"
	Cwm Buchan, third coal series.	Four ft. upper vn,	4	0	91.67	7.70	0.63	strong, heavy coal.
		" lower pt,	4	0	88.65	10.00	1.35	reedy, furnaces.
		Nine feet coal,	9	0	83.74	15.20	1.06	large and lumpy.
		Yard coal,			78.90	20.00	1.10	clean and bright.
	Pyle, lower series.	Vein fawr, 1,	9	0	72.82	24.68	2.50	very bright, reedy c'l.
		" 2,	9	0	72.58	24.42	3.00	cannel and bit's mixed.

Bituminous and semi-bituminous or steam Coals of South Wales, on the south-eastern side of the Coal Basin.

By the term "reedy coal," is locally understood a coal in which the vegetable impressions are conspicuous and abundant in its substance,—"Clod coal," having a soft, laminated, vegetable texture,—"Splint coal," which does not lose its form in coking, angular,—"Semi-bituminous coal coke," where the angles of the cokes are rounded, and having considerable adhesion,—"Partially bituminous," where the coked masses have rounded edges, and slightly adhere together,—"Bituminous cokes," those which dissolve and enter into fusion, forming a compact mass.

	Description, locality, and names of coal seams.		Thickness of each vein. ft.	in.	Analysis of 100 parts of coal, by D. Mushet. Carbon.	Bitumen, vol. matter, &c.	Ashes or cinders.	The Coal described, and its uses.
	Mynyddys-lwyn vein, sale coals for household purposes. *Upper or red ash coals.*	Cyfarthfa furnace,			88.07	8.50	3.43	irregular crystallized.
		Powell's,	4	0	66.58	27.92	5.50	cubical, compact, reedy.
		Morrison's,	4	0	68.58	36.92	4.50	" "
		Penner vein,	4	0	60.25	33.00	6.75	slightly granular, reedy.
		Cwm Dows, (Morrison,)	3	4	68.86	27.14	4.00	cubical.
		Prothero's,	4	0	64.95	33.30	1.75	" compact.
		Rosser Williams,	4	0	63.50	30.00	1.50	no sulphur, clean.
		Crossfields,			69.34	24.16	6.50	cubical, compact.
	Beddws vein. *Lower red ash coal.*	Cwm Tillery,	2	4	64.45	24.80	10.75	shining bright.
		Phelps's,	2	4	68.00	30.00	2.00	compact, hard, strong.
		Abercarne,	2	9	66.88	28.37	4.75	" cubical, reedy.
		Cwm Carne,	2	9	62.63	31.10	6.25	" " "
The white ash or furnace Coals.	Risca veins.	Upper Rock vein,	3	6	66.11	31.14	2.75	for steam packets.
		Lower Rock vein,	3	6	61.78	34.28	3.94	oblong masses, reedy.
		Big vein,	12	0	66.02	29.15	2.83	irregular, no sulphur.
		Red vein,			61.25	33.80	4.95	pyrites, strong.
		Sun vein, [or Meadow vein,]	3	0	67.28	31.34	1.38	compact, reedy.
	Cwm Brane coals.	Yard vein,	2	0	63.03	32.60	4.37	with layers of splint.
		Rock vein,	6	0	62.22	34.78	3.00	cubical.
		Red vein,	3	6	60.65	31.35	8.00	oblong reedy.
		Meadow vein,	5	8	66.34	28.16	5.50	strong, bright, shining.
		Old coal,	3	0	68.30	27.70	4.00	cubical, tarnished.
	Blaen-dare furnace c'ls.	Rock vein,	10	0	68.86	28.64	2.50	used for blast furnaces.
		Meadow vein,	6	0	67.84	29.16	3.00	" "
	Pen Twyn furnace coals.	Big vein,	4	6	71.88	25.50	2.62	laminæ regular, reedy.
		Droydeg, or Rock vein,	3	6	68.20	24.80	7.00	cubical,
		Meadow vein,	7	0	63.65	32.60	3.75	cross or sectional, pure.
		Old coal,	2	6	68.50	27.50	4.00	incompact, friable.
	Abersychan British Iron Company.	Red vein,	4	0	72.95	25.30	1.75	used raw in blast furn'cs.
		Big vein,	7	0	67.05	25.70	7.25	" " "
		Rock vein,	8	0	69.30	25.70	5.00	cubical splint.
Bit's c'ls of S. Wales, s'th side the c'lb'sn.	Park, south veins of the S. Wales c'l basin, between Pyle and Llantrissant.	Cribbwr Vach,	4	6	72.36	26.14	1.50	bright, furnaces.
		Bedws vein,	10	0	70.68	25.82	3.50	" in thin laminæ.
		Maesteg issa,	5	0	79.69	19.26	1.25	" blast furnaces.
		Llangonydd,	5	0	60.40	38.60	1.00	"
		" No. 2,	2	6	69.64	27.86	2.50	imperfectly rhomboidal.
		" 20 inch.	1	8	70.22	28.28	1.50	broad, reedy coal.
		Hirwain common,	4	6	69.34	29.16	1.50	smooth fracture.
		" 2 y'd c'l,	4	0	73.75	22.50	3.75	slaty, partially reedy.
		Llanharry,	6	0	65.75	33.00	1.25	strong, reedy coal.
		Collenna 3 feet,	3	0	75.06	23.44	1.50	broad, reedy structure.
		" cannel c'l,	3	0	63.25	34.12	2.63	laminated, oolitic.
	Mellin Criffin and Pentyrch, near Cardiff.	Little vein,			70.66	27.34	2.00	workmen's fires.
		Brassey vein,	2	4	61.00	30.00	9.00	heavy, forges and mills.
		Pentyrch hard vn,	4	0	71.25	23.75	5.00	crystallized, blast furn's.
		" forked vn,	5	6	64.63	31.87	4.50	reedy, tin plate works.
		" wing coal, pure anthracite,	5	0	95.69	2.81	1.50	" furnace and forge.
	Very dry Coals, with excess of carbon in S. Wales.	Dowlais iron w'ks,			79.50	17.50	3.00	lamellar, does not cake.
		Cyfarthva "			78.40	18.80	2.80	" cakes.
		Pen-y-daran, "			76.80	20.00	3.20	" "

Anthracite of South Wales, towards the western extension of the Basin.

Description and Locality of coal beds.		Thickness of each vein. ft.	in.	Analysis of 100 parts of coal, by D. Mushet. Carbon.	vol. matter, &c.	Ashes or cinders.	The Coal described.
Pwll-feron, in Neath valley, Neath Abbey furnaces.	Pwll feron vein, 1st bed,	18	0	89.34	6.66	4.00	mixed with coke.
	2d "			86.56	6.94	6.50	very hard and reedy.
	3d "			86.24	12.00	1.76	anthracite.
	4th "			90 59	8.50	0.91	".
	5th "			91.08	8.00	0.92	more brilliant.
	6th "			81.00	9.00	10.00	more reedy.
Yyiscydwn iron works.	Big vein,			88.70	7.80	3.50	
	Brass vein,			88.70	7.80	3.50	
	Cwm Phil vein,			89.60	6.66	3.74	bright and shining.
Swansea.	Swansea peacock coal,			89.00	7.50	3.50	surface smooth.
Ystal-y-ferra iron works, Swansea valley.	Big vein, 1st bed,	6	0	91.42	7 08	1.50	blast furnaces.
	" 2d "			92.89	5.61	1.50	flat, boarded coal.
	" 3d "			91.99	6 51	1.50	reedy and granular.
	Cefn v. upper bed,			91.26	7.24	1.50	pitchy, bright, shining.
	" lower part,			91.89	6.61	1.50	partially granular.
	Brass v. upper pt,			92.46	6.04	1.50	bright, laminæ irregular.
	" lower pt,			91.52	6.98	1.50	irregular, reedy.
	Black vein,			93.14	5.36	1.50	rough, crystallized.
	Little vein,			90.64	7.86	1.50	regular but twisted.
	Pentyrch wynn,	5	0	95.69	2.81	1.50	reedy, forge and furnace.
Cwm Neath.	Three feet vein,	3	0	94.10	4.90	.93	analysis by D. Schafhaeutl.
	Eighteen ft. vein,	18	0	91.43	6.24	2.28	
	Nine feet vein,	9	0	93.12	5.22	1.59	
Bituminous coals of the forest of Dean, Gloucestershire.	Cinderford fur'ce, or Lower High coal Delf,	3	0	62.00	36.00	2.00	strongly reeded, bright.
	Park-end coal,	4	0				free from splint.
	Coleford High Delf, top pt,	4	6	63.72	32.03	4.25	thin, bright laminæ.
	Middle part,	to		63.61	34.89	1.50	reedy, bright, pyritous.
	Bottom part,	6	0	60.96	37.29	1.75	smooth fractured.
	Church-way c'l. top,	5	0	60.33	35.67	4.00	irregular fracture.
	Church-way c'l. bottom,			64.13	34.74	1.23	smooth, straight, reedy.
	Rocky vein,	2	0	61.73	36.14	2.13	strong, partially reeded.
	Starkey coal,	2	6	61.53	36.72	1.75	partially reedy.
	Park-end, Little Delf,	1	8	58.15	36.35	5.50	compact, bright, reedy.
	" Smith end,	2	0	63.36	34.89	1.75	heavy, compact, "
Bituminous coals of Staffordshire. Corbyn's Hall.	Tow coal, part of the 10 y'd coal,			51.90	40.60	7 50	strong, reedy coal.
	" "			56.00	42.50	1.50	irregularly laminated.
	Heathing coal,			54.17	43.33	2.50	strong, bright, reedy.
	Brooch coal,			50.49	47.76	1.75	bright, pitchy fracture.
South Staffordshire.	New mine top c'l,			52.77	45.10	2.13	reedy, without splint.
	Fire clay coal,			51 40	46.35	2.25	weak, friable, reedy.
	New m. bot'm c'l,			53.98	44.27	1.75	reedy, mixed with clod.
Bentley Estate, South Staffordshire.	Ten yard coal,			54.05	42.70	3.25	pitchy, bright coal.
	" bottom pt,			63.57	34.18	2.25	bright and thin splint.
	Four feet coal,	4	0	53.18	44.82	2.00	bright, shining, smooth.
	Three feet coal,	3	0	54.82	43.12	2.00	bright, pitchy, reedy.
	Fire clay coal,	5	0	54.84	42.91	2.25	strong, reedy, uniform.
	Bottom vein,	7	0	62.87	32.00	5.12	hard, splint coal.
	Five ft. splint c'l,	5	0	49.42	45.83	4.75	laminæ minute.
	Bottom coal,			79.78	10.72	9.50	imperfectly crystallized.
Lane end, North Staffordshire.	Bassey mine coal,			58.30	38.70	3.00	reedy, dull surfaced.
	Little mine coal,	4	0	62.30	35.20	2.50	compact.
	Great row coal,	9	0	57.38	39.74	2.88	smooth, thin laminæ.
	Best furnace coal,	10	0	65.20	32.30	2.50	bitumn's looking coal.
	Ashes coal,			61.32	37.18	1.50	bright, shining, cubical.

Bituminous Coals of Staffordshire, Shropshire, North Wales, Derbyshire, and Yorkshire.

Locality	Description and Locality of coal veins.	Thickness of each seam. ft. in.	Anal. of 100 parts coal, by Mushet. Carbon.	Bitu'n, vol. matter, &c.	Ashes or cinders.	The Coal described, and its uses.
North Staffordshire. Kidsgrove.	Little Row coal,	4 0	63.08	34.67	2.25	bright, with clod partings.
	Seven feet coal,	7 0	67.90	30.47	1.63	thin layers, furnace.
	Stony vein,	8 0	65.17	33.33	1.50	compact.
	Banbury or Harecas,		63.84	35.16	1.00	bituminous.
	Knowles' coal, Delph Lane,	10 0	59.64	37.86	2.50	bright, free burning.
	Peacock coal, Fenton Park,	9 0	60.42	37.08	2.50	cubical, furnaces.
Golden H.	Spendcroft vein,	4 0	58.67	39.58	1.75	broad, potteries.
	Ten feet coal,	7 0	58.89	39.11	2.00	uniformly reedy, potteries.
	Great Row coal,	8 0	60.80	37.70	1.75	cubical, pott's & salt w'ks.
	Little Row coal,	4 0	62.47	34.53	3.00	hard, " "
Shropshire.	Shropshire stone coal,		58.17	39.20	2.63	bright, clod partings.
	Sulphur coal,		55.72	42.03	2.25	broad, for inf. house purp.
	Clod coal,		63.79	35.58	1.63	reedy, furnaces.
	Randle coal,		64.19	32.81	3.00	" "
	Flint coal,		60.63	36.87	2.50	hard, sale or smith's use.
	Top coal,		64.10	34.77	1.13	regular.
	Best fungous coal,		63.33	35.67	1.00	minutely lamin. no pyrites.
	Double coal,		57.87	41.38	.75	hard, blast furnace.
North Wales. Brymbo Coals.	Three y'd coal, part not coked,		61.31	35.80	2.89	fine, "
	" part coked,	3 0	62.70	35.70	1.60	strong, "
	Two yard coal coked,		69.98	28.60	1.42	bright, "
	Brassy vein coked,	5 6	64.58	34.10	1.32	cubic, "
	Crank coal,	2 6	73.56	25.70	.74	mixed, furnace and sale.
	Drowsall vein,	5 0	62.69	36.70	.60	not firm, free.
	Powell vein,	5 0	63.41	34.80	1.79	shining.
Dee Bank.	Five yard vein, top part,		61.89	36.20	1.91	laminated, free.
	" middle,		62.72	36.00	1.28	more compact, iron mak'g.
	" bottom,		63.79	32.85	3.36	thin laminæ, with clod.
	Three yard coal,		62.88	36.00	1.12	compact, free.
	Two yard coal,		60.61	38.47	.92	free, shining fracture.
	Bone coal,		55.20	40 00	4.80	hard, lead works.
North Wales.	Pankey Iron works, stone vein,	2 0	61.95	35.67	2.38	broad, part'ly crystallized.
	Pant Iron w'ks, blast fur'ce coal,	1 7	67.25	31.25	1.50	granular, for blast furnace.
	Coed Talon, "	9 0	58.50	40.00	1.50	surface, "
	Sweeny Colliery, brassy vein,	3 0	49.94	34.56	15.50	alternate layers, "
	Cefn Colliery n'r Rhuabon works,	7 0	57.49	36 56	6.25	"
	" brassy coal,	3 0	66.37	32.13	1.50	laminated.
	Black Park coal, 2 yard vein,	6 0	57.50	40.00	2.50	firm, with splint.
	" 1½ yard vein,	4 6	59.88	38.12	2.00	strong, with clod.
	Llwyn-y-onnion, ½ yard coal,		62.85	34.40	2 75	smooth, reedy, blast fur'es.
	Chirke bank C'ry, stranger's coal,	5 6	57.00	40.00	3.00	hard.
	Delf C'ry, y'd vein n'r Rhuabon,		64.89	34.11	1.00	compact.
Derbyshire.	Kirby, upper hard or main coal,	6 0	64.15	33.85	2.00	mixed, shining parting.
	Dunshill near Swanwick,		55.77	40.73	3.50	strong, breaking oblong.
	Swanwick, main coal,		60.27	38.23	1.50	" twisted laminæ.
	Main, upper hard, Duckmanton,		64.47	32.03	3.50	" blast furnaces.
	Normanton Com. Codnor park c'l,		56.21	41.66	2.13	free, forge and mills.
	Main soft coal,		56.49	37.76	5.75	" clod, spar.
	Alfreton works, Lower hard c'l,	4 0	62 60	35.15	2.25	strong, blast furnaces.
	Butterly p'k C'ry, " "		61.14	34.11	4.75	splint. "
	Morely p'k w'ks, " "		55.89	37.86	6.25	" "
	Chesterfield, " "		61.65	35 10	3.25	mixed, good cleavage.
	Double or Minge coal,		60 66	37.34	2.00	bright, furnaces.
	Clod coal,		61.21	37.29	1.50	smooth fracture.
	Buckland hollow or Killburn coal		58.62	40.00	1.38	broad, smooth fracture.
	Moreley Park, cannel coal,		45.00	45.05	9.95	conchoidal.
	Cannel coal near Alfreton works,		55.27	40.73	4.00	beautiful, specular.
Yorkshire.	Low Moor, better bed,	2 4	67.06	32.19	.75	dense, furnace and forge.
	" black bed,	1 8	71.42	27.08	1.50	friable, domestic use.
	Bowling, better bed,	1 10	64.25	32.55	2.00	bituminous, fur. and forge.
	" crow coal,	1 8	66.15	33.85	1.00	distinct, with clod, sale.
	Parkgate, main coal.	7 0	67.14	30.73	2.13	4 feet, blast furnaces.
	Old Parkgate vein,	4 6	65.09	33.28	1.63	hard, in laminæ, "

Fat, bituminous Coals of Yorkshire and Scotland.

Description and Locality of Coal Veins.	By whom analysed and described.	Thickness of eac seam. ft. in.	Analysis of 100 parts of Coal. Carbon.	Bitumen, volatile matter, water, &c.	Ashes or cinders.
YORKSHIRE.					
Parkgate, top coal, upper part of the 7 feet coal,	D. Mushet,	1 4	62.51	36.49	1.00
do. bottom part,	do.	1 8	66.94	31.56	1.50
Birkenshaw coal,	do.		64.96	32.54	2.50
Worsboro. furnace coal,	do.	9 0	60.32	38.18	1.50
do. another specimen,	do.		56.45	40.85	2.50
Milton, main coal, splint part,	do.	9 0	69.40	27.60	3.00
do. roof or soft part,	do.		62.71	36.04	1.25
Thorncliffe, thin furnace coal,	do.	2 6	63.98	35.52	.50
Smithy, wood coal,	do.	2 6	54.60	44.27	1.13
Easley Park,	oo.	1 7	69.12	30.00	.88
Yorkshire Kent, coal,	do.	5 0	66.40	32.72	.88
Strafford, main coal, 5 ft. bottom part,	do.	3 0	62.08	35.67	2.25
do. do. top part,	do.	2 0	68.12	30.20	1.68
Silkstone, main coal,	do.		65.08	32.29	2.63
do. soft or clod coal,	do.	5 0	63.10	35.15	1.75
SCOTLAND.					
Clyde, upper vein, top,	do.		37.00	41.50	21.50
do. do. bottom,	od.		53.45	44.80	1.75
do. do. second vein,	do.		42.10	48.34	9.56
do. third or furnace,	do.		51.20	45.50	3.30
do. fifth splint coal,	do.		53.40	42.40	4.20
Calder, furnace coal, top,	oo.		49.98	43.82	6.20
do. do. splint part,	do.		50.67	47.48	1.85
do. do. main coal, top,	do.		49.60	49.39	1.01
do. do. middle,	do.		52.30	39.95	7.75
do. do. bottom,	do.		51.60	44.51	3.89
Glen Buck, furnace coal,	do.		53.20	45.20	1.60
do. inferior "	do.		48.80	44.20	7.00
Cleugh, furnace coal,	do.		47.08	42.25	10.67
Omoa, splint "	do.			46.62	
do. bright, "	do.			47.29	
Marystone Pyat, shaw coal, top,	do.		49.60	49.31	1.09
do. pine splint,	do.		51.82	46.57	1.61
do. heavy splint,	do.		54.67	39.25	6.08
Fat, bituminous Coals.					
Govan coal, first vein, top part,	do.		49.55	44.65	5.80
do. lower part,	do.		49.41	48.92	1.67
do. second vein,	do.		42.20	48.34	9.46
do. fifth vein, splint,	do.		48.84	49.79	1.37
do. sixth vein, lower main,					
1. Craw coal,	do.		51.58	44.60	3.82
2. Head coal,	do.		48.08	49.38	2.54
3. Ground coal,	do.		45.57	51.00	3.43
4. Foot coal,	do.		52.27	44 15	3.58
Lismahago, cannel coal,	do.		39.43	56.57	4.00
Dry Coals, not very adhesive.					
Clyde, splint coal,	do.		59.00	36.80	4.20
do. do.	Thomson.		55.23	35.27	9.50
do. clod coal,	D. Mushet.		70.00	26.50	4.50
do. soft coal,	Thomson.		42.25	47.75	10.00
do. near Glasgow,	Dufrenoy and Berthier,		64.40	31.00	4.60
Calder, do.	do.		51.00	45.00	4.00
Monkland, do.	do.		56.20	42.40	1.40
Middlerig,	Dr. Fyfe,		50.50	42.00	7.50
Scotch coal,	W. R. Johnson,		48.81	41.85	9.34
Scotch cannel,	do.		60.34	36.95	2.71
do.	Dr. Ure,		39.40	56.60	4.00

Anthracites of Europe.

Localities.	By whom examined and analysed.	Specific gravity.	Analysis 100 parts. Carbon.	Hydrogen, water and volat. matter.	Silica and ashes.
South Wales.					
Anthracites.					
Welsh anthracite, Cwm Neath,	Dr. Schafhaeutl,		92.42	5.97	1.91
			94.10	4.90	93
Ynis Cedwin, Crane,	Jno. F. Frazer,		86.60	7.60	5.80
"	W. R. Johnson,	1.336 1.372	87.60	9.18	4.32
Welsh stone coal,	D. Mushet,	1.368	89.70	8.00	2.30
Welsh slaty stone coal,	"	1.409	84.17	9.10	6.73
Mean of several varieties of Welsh coal,	Dr. Ffye's Exper.	1.354	71.40	17.80	10.80
European Continent.					
Anthracitous Coals.					
The Alps, Isere, Canton of Launure,	M. Robin,				4.0
Canton of Lanton, near Grenoble,	"	1.072			
Westphalia,	M. Karsten,	1.358			
"	"	1.336			
Mean analysis of twelve varieties of anthracite,	Berthier,		79.15	7.37	13.25
Dry or slightly bituminous Coals.					
Ireland.					
Kilkenny, Leinster,	D. Mushet,	1.602	92.88	4.25	2.87
" slaty or cannel,	"	1.445	80.47	13.00	6.53
Boolavoonein, stone coal,	"	1.436	82.96	13.80	3.24
Corgee, "	"	1.403	87.49	9.10	3.40
Queen's county, Leinster,	D. Mushet,	1.403	86.56	10.30	3.14
Kilkenny, cannel,	Karsten,		74.47	25.01	.50
Kilkenny,	Dr. C. T. Jackson,		79.60	12.00	8.40
Scotland.					
Coal, under Basalt, Renfrewshire,	D. Mushet,		69.74	16.66	13.60
France.					
Mean of twelve specimens,	M. Berthier,		79.15	7.37	13.25
Côte d'or, Sincey,	De Nerville,		82.60	8.60	8.80
Mais Salze,	M. Varin,		83.00	7.50	9.50

Bituminous Coals of France.

Departments, Coal basins, and varieties of Coal.	Locality.	Concessions.	By whom analysed.	Specific gravity.	Analysis. Carbon.	Volatile matter.	Ashes.
Coal of the Bourbonnais, department of Allier. Basin of Fins.	Montet,		M. Baudin,	1.38	75.23	24.77	
	Gabeliers,		"	1.34	74.92	25.08	
	Deux Chaises, Chapelle,		"	1.48	74.22	25.78	
	Fins,		"		68.28	31.72	
	Noyant,		"	1.30	62.49	37.51	
Basin of Bussiere-la-grue.			"	1.34	54.76	45.24	
Basin of Bert.			"	1.36	58.47	41.53	
					64.20	35.80	
Basin of Commentry.	Commentry,		M. Regnault,		63.20	36.60	1.20
	Chambled,	Marais,	"	1.38	87.85	12.15	
	Commentry,	Amenat,	"	1.27	60.00	40.00	
	Néris,	Great bed,	"	1.35	58.87	41.13	
	Id.,	Ferrières,	"	1.31	56.76	43.24	
Basin of Doyet.	Doyet,	La Souche,	"	1.30	61.23	38.77	
	Monticq,	Bourdignat,	"	1.28	59.58	40.42	
	Id.,	Chauvais,	"	1.30	58.61	41.39	
	Bezenet,	Grande masse	"	1.32	56.84	43.16	
Champagnac in the coal basin of Haute-Dordogne—Cantal.	Mines de Lempret,	New bed, 1	M. Baudin,	1.26	66.60	30.19	4.60
		2 metres, 2		1.33	56.30	29.80	13.90
		3		1.36	53.20	30.30	16.50
		Upper bed, 4	"	1.28	65.70	30.10	4.20
		5		1.27	62.40	30.60	7.00
	Mine de Madie,	First or lowest bed, 6	"	1.28	60.70	32.90	6.40
		2d bed, 7	"	1.28	64.00	31.60	4 40
	Mauriac,	Madie,	M. Berthier,		61.00	34.50	7.50
Coal basin of la Haute-Dordogne, Cantal.	1, Messeix,	Clydance,	"	1.39	85.49	14.51	
	2, Singies,	Morilleux,	"	1.38	71.27	28.73	
	3, Lempret,	New bed,	"	1.38	69.10	30.90	
	4, Madie,	2 Bed,	"	1.27	68.97	31.03	
	5, Prodelles,	3 Bed,	"	1.40	67.28	32.72	
	6, Vendes,	Champlaix,	"	1.38	66.08	33 92	
	7, Madie,	1st Bed,	"	1.31	66.05	33.95	
	8, Singles,	Ginguette,	"	1.32	65.14	34.86	
	9, Lempret,	C. de l'air,	"	1.35	63.08	36.92	
	Mandailles,	Lignite,	"	1.29	41.45	58.55	
	Chambeuil,	Lignite,	"	1.28	40.88	59.12	
Auvergne, Central France, department of Puy-de-Dôme. Coal Basin of Brassac.	1, Charbonnier,	Great bed,	M. Baudin,	1.43	86.41	13.59	
	2, La Combelle,	"	"	1.38	80.31	19.69	
	3, "	La Ronziere,	"	1.36	78.82	21.18	
	4, Armots,	Fontaine-du-Chien,	"	1.38	77.48	22.52	
	5, "	Chamas,	"	1.41	76.79	23.21	
	6, Gras Ménil,	Great bed,	"	1.35	75.31	24.69	
	7, Fondary,	Les Vignes,	"	1.30	75.15	24.85	
	8, La Taupe,	Arrest,	"	1.32	73.89	26.11	
	9, Mégécoste,	6th bed of 4 f.	"	1.34	73.01	26.99	
	10, La Taupe,	Great mass,	"	1.33	71.80	28.20	
	11, Les Barthes,	Batard of 3 ft.	"	1.36	74.40	28.60	
	12, "	8 feet bed,	"	1.39	70.14	29.86	
	13, Mégécoste,	7th bed of 8 f.	"	1.34	70.09	29.91	
	14, Les Barthes,	3 feet,	"	1.45	70.07	29.93	
	15, Mégecoste,	6 feet bed,	"	1.34	69.86	30.14	
	16, Les Barthes,	3 feet,	"	1.35	68.64	31.34	
	17, Mégécoste,	7 feet,	"	1.49	67.08	32.92	
	18, Les Barthes,	Le Feu,	"	1.33	66.78	32.22	
	19, Brioude,	Preissat,	"	1.32	59.43	40.57	

Bituminous Coals of France, Department of Puy-de-Dôme.

Departments, Coal basins, and varieties of Coal.	Locality.	Concessions.	By whom analysed.	Specific gravity.	Analysis.		
					Carbon.	Volatile matter.	Ashes.
Basin of Brassac, mines of La Taupe and Arrest.	Nr. Guinguette,	Cingles,	M. Baudin,		63.90	32.00	4.10
		Agassiz bed,	"	1.340	65.00	26.40	8.60
		La Louise bed,	"	1.310	68.50	26.80	4.70
		Four feet bed,	"	1.320	66.20	27.00	6.80
		La Felicite bed,	"	1.300	67.50	26.00	6.50
		La Trouelle,	"	1.330	66.10	26.30	6.60
Basin of St. Eloy, or Montaigne.	La Roche,		"	1.300	59.80	40.20	5.20
	La Vernarde,		"	1.300	60.40	39.60	8.70
Basin of Bourg Lastic.	Messeix,		"	1.390	86.24	13.76	5.20
	Singles,		"	1.380	75.00	25.00	13.00
	Singles,		"	1.320	68.00	32.00	8.20
	Puy St. Gulmier,	Du Chiex,	"	1.340	84.45	15.55	
	La Besette,	Vazazène,	"	1.280	66.75	33.25	
Saône and Loire. Basin of Creusot and Blanzy.	St. Bérain,	Molliere,	M. Gruner,		74.00		28.52
		Jumeaux,	"		68.75		22.63
		" 1st classe,	"		68.75		24.00
		Vignes,	"		73.52		26.50
		Quatre Bras,	"		66.80		19.80
		St. Charles,	"		69.25		22.10
	Maillot,		"		59.50		12.20
	Communautés,		"		67.75		5.45
	Montchanin,		"		61 25		9.00
	Longue Pendue,		"		60.00		8.00
	Ragny,		"		63.20		8.55
	Blanzy,	Montceaux,	"		58.00		5.00
	Lucy,	Lucy,	"		65.00		14.00
Saone et Loire,	Basin of Epinac,		Regnault,		61.10	36.40	2.50
Provence. Basse Alpes.	Volx,	Lignites,	M. Diday,		51.70	42.50	5.80
	Dauphin,				49.20	46.30	4.50
	Volx,				39.20	45.80	15.00
	Dauphin,				34.70	53.10	12.20
	Sigonce,				40.60	52.40	7.00
	Manosque,				31.20	50.50	18.30
	Villemus,				38.90	51.50	9.60
	Pierre-vert,				28.00	45.80	26.20
Var.	Cadiere,				48.10	44.80	7.10
	St. Zacharie,				32.40	61.60	6.00
	Beausset,				40.60	39.40	20.00
Vaucluse.	Méthamis,				40.90	50.00	9.10
	Piolenc,				26.60	51.10	22.30
	"				41.50	52.30	6.20
	Montragon,				36.80	48.20	15.00
Fat Coals, very rich in Carbon, first class. Basin of Saint Etienne.	Du Soliel,	Montcel,	M. Gruner,		77.59	19.60	2.81
	St. Marie,	Chaney, 1	"		74.81	21.67	3.52
	St. Claude,	Méons, 1	"		74.31	24.17	1.52
	St. Claude,	Méons, 2	"		73.80	23.13	3.07
	St. Marie,	Chaney, 2	"		73.78	24.33	1.89
	Reveux,	Reveux,	"		72.73	22.83	4.44
	St. Claude,	Méons, 3	"		72.13	24.47	3.40
	Caraude,	Cote-Thiolière,	"		69.13	25.67	5.20
		Grande couche du cros.	"		69.27	24.50	6.23

Bituminous Coals of France, Department of Puy-de-Dôme.

	Departments, Coal basins, and varieties of Coal.	Locality.	Concessions.	By whom analysed.	Analysis. Carbon.	Volatile matter.	Ashes.
Saint-Etienne.	2d class. Ordinary Coals of Saint-Etienne.	Chené,	5. De la Roche,	M. Gruner,	67.96	28.47	3.57
		Vincent,	5. Bérard,	"	66.66	29.20	4.14
		Deville,	3. De la Roche,	"	65.72	31.90	2.38
		"	3. "	"	61.05	32.54	6.41
		"	7. "	"	66.35	28.27	5.38
		St. André,	Méons,	"	65.68	27.83	6.49
		Pompe,	7. Du Treuil,	"	62.89	29.73	7.38
		"	7. "	"	58.81	26.03	15.16
		Vincent,	7.Bérard,	"	63.71	25.27	11.02
		"	6. "	"	63.94	27.13	8.93
	3d class. Fat Coals, longue flamme.	Montrambert,	Great bed, 1st quality,	"	57.82	34.10	8.08
		"	2d "	"	54.56	35.43	10.01
		Littes,	Beraudière,	"	58.79	35.57	5.64
		Great bed,	1st quality,	"	59.29	35.20	5.51
Lignite Beds.	Bouches du Rhone.	Lignites of Greasque,	Mène du haut, 1	M. Diday,	48.20	49.00	2.80
			Bleu, 2	"	48.50	48.00	3.50
			Menette, 3	"	45.60	49.60	4.80
			Maitre Jean, 4	"	41.90	51.60	6.50
			La Fortune, 5	"	44.70	52.30	3.00
			La Saoude, 6	"	43.70	47.80	8.50
			La Ravette, 7	"	39.10	53.90	7.00
Peat.	Ardennes,	Séchwal,	Peat,	M. Sauvage	22.00	69.70	8.30
	Basses-Alpes,	Lauzanier,	"	M. Diday,	9.00	58.00	33.00
Lignite Beds.	Basses-Pyrénées,	Bayonne,	Lignite,	M. Gruner,	48.20	38.10	13.70
	Lozère, and	Rosiers	"		50.70	47.60	1.70
	Aveyron,	Peyre lau	"	M. Cochon,	49.10	46.20	4.70
	Gard,	Alais,	St. Christol, lig.	M. Varin,	34.00	46.00	20.00
	Bouches-du-Rhone,	Rocher Bleu,	Great lig'te bed,	M. Diday,	50.20	46.30	3.50
		Belcodène,	Smaller beds of lignite,	"	45.20	52.40	2.40
					26.50	53.50	20.00
	Var,	Collobrieres,	Coal,	"	63.00	28.00	9.00
Bituminous Coals in France.	Coals in Arrondissement of Alais. Department of Gard.	La Grande Combe,	1. Fournier,	M. Varin,	76.00	16.00	8.00
			2. Plomb,	"	70.00	17.00	13.00
			3. La Barraque,		80.50	14.50	5.00
			4. Abilon,	"	81.00	14.00	5.00
			5. Velours,		75.00	14.00	11.00
			6. Bosquet,	"	74.00	20.00	6.00
			7. Rotschild,		73.50	16.50	10.00
		Prescol,	8. Levade,		77.00	18.00	5.00
			9. Trois-Machoires,	"	77.50	18.00	4.50
			10. Cing-pans,	"	78.00	19.50	2.50
		Partes,	11. Taranière,		65.00	18.50	16.50
			12. Rowière,	"	78.50	14.00	7.50
		Bessége,	13. Great bed,	"	67.50	20.50	12.00
		Champelauzon,	14. Champelauzon,		79.50	13.00	7.50
		St. Jean-de-Valerisle,	15. Remise,	"	72.00	9.00	19.00
		St. Paulet,	16. Lignite,	"	36.50	51.00	12.50
		Connaux,	17. "	"	35.00	51.00	14.00

Bituminous Coals of France, Department of Puy-du-dôme.

Departments, Coal basins, and varieties of Coal.	Locality.	Concessions.	By whom analysed.	Specific gravity.	Analysis. Carbon.	Volatile matter.	Ashes.
Coal basin of Alais, department of Gard,	1. Bességе,	Coal,	M. Varin,		68.50	25.50	6.00
	2. Saint Cristol,	Lignite,	"		34.00	46.00	20.00
	3. Grand Combe,	Coal,	"		80.50	17.00	2.50
	4. "	Pin bed,	"		74.00	18.50	7.50
	5. Bességе,	Coal,	"		63.00	24.50	12.50
	6. Grand Combe,	Plomb,	"		77.50	19.00	3.50
	7. Cessous,	Mean of 3 exper.	"		78.30	17.70	4.00
	8. "	Masse bed, 3 do.	"		58.50	26.50	15.00
	9. "	Salze bed, 2 do.	"		83.00	7.50	9.50
	Rochebelle,		M. Berthier,		68.00	21.60	11.40
Hérault,	Saint-Gervais basin.	Concessions of Bousquetd'orbe and Graissesac, 2	M. Garella,		56.50	17.00	26.50
		3	"		77.50	19.00	3.50
		4	"		70.50	16.00	13.50
		5	"		69.70	15.00	15.40
		6	"		65.20	18.50	16.30
		Graissesac,	M. Gruner,		68.80	31.20	15.30
		St. Gervais,			85.16	14.84	14.05
					78.30	16.40	5.30
Aveyron,	Basin of Aubin, or Decazeville,	Paleyret, No. 3.	M. Senez,		67.50	26.60	5.90
		do. 4.	"		61.00	32.80	6.20
		Bourran,	"		71.50	24.60	3.90
		Fontanges,	"		63.00	27.20	4.20
		Fareiret,	"		53.00	38.30	8.70
		Bouquiès,	"		69.80	25.10	5.10
		Cransac,	"		53.20	39.30	7.50
		Lavergne,	"		50.00	42.00	8.00
		Le Poux,	"		55.00	38.00	7.00
		Lagrange,	M. Regnault,		61.20	34.20	4.60
Tarn,	Basin of Carmeaux,	Grand-Vein,			72.60	23.60	3.80
		Castillan,			74.50	20.90	4.60
Aude,	Basin of Ségure,		M. Berthier,		56.00	24.00	20.00
			M. Bouis,		60.00	22.00	18.00
			M. Leplay,		71.60	24.00	4.40
	Basin of Durban,		M. Berthier,		49.00	33.50	17.50
Nord,	Basin of Valenciennes,	Anzin, bitumens,	Chevalier,	1.284	74.25	25.00	0.75
		Fresnes anthra'e,	"	1.360	89.30	7.20	3.50
		Anzin,	Berthier,	1.284	71.50	25.00	3.50
Haute-Saône,	Gémonval,	Corcelles & Lure,	M. Drouot,	1.440	48.90	36.60	14.50
Vosges,	Norroy,		M. Regnault,	1.410			
Rhône,	Rive-de-Gier,	Grand-Croix,		1.298	67.20	31.00	1.80
				1.302	68.80	29.80	1.40
		Cimitière,		1.288	68.40	28.00	3.60
				1.294	67.00	30.00	3.00
		Couzon,		1.298	62.80	34.50	2.70
				1.311	62.10	32.60	5.30
		Corbeyre,		1.315	74.00	23.00	7.00
		Couzon,	M. Gruner,		63.55	30.93	5.52
		Grézieux,	"		62.54	25.10	12.36
		Couzon,	"		62.57	30.07	7.34
Doubs,		Morteau,	M. Boyé,		29.50	53.50	17.00
		Flangebouche,	"		30.00	62.00	8.00
Jura,		Orbagna,	"		30.50	57.50	12.00

Analysis of Combustibles, Europe.

Departments, and varieties of Coal.	Locality.	Designation of Coal beds.	By whom analysed.	Analysis. Carbon.	Volatile matter.	Ashes.
Deux Sévres,	Chantonnay,	Main coal,	M. Boyé,	62.70	20.00	17.30
Vendee,	Basin of Vouvant,	Faymoreau,	M. Berthier,	61.15	29.50	6.15
				65.10	27.50	7.40
Loire Inférieure,	Ancenis,	Guignardiere,	M. Sentis,	58.50	31.00	10.50
Finistèrre,	Plogoff,	Cap. Sziain,	"	63.00	25 00	12.00
FRANCE. Coals of Maine et Loire.	Layon et Loire,	Pits of Saint Barbe,	M. Sentis and M. Lechatelier,	80.21	17.00	3.79
				77.59	18.00	4.41
		Du Bocage,		82.39	13.20	4.41
		Des Barres,		67.03	16.60	16.37
		The West,	"	69.92	18.00	12.08
	Mont-jean,	St. Nicholas,	"	65.88	23.40	10.72
				73.76	22.34	3.90
		Beau-soliel,	"	74.02	19.20	6.78
	St. Georges, Sur Loire,	The Arch,	"	63.40	27.87	8.73
	Chaudefonds,	St. Barbe,	"	73.57	10.00	16.43
		St. Nicolas,	"	71.78	11.60	16.62
	St. Georges, Chatelaison,	Conception,	"	72.71	15.60	11.69
				65.00	23.80	11.20
		Adele,	"	80.99	9.40	9.61
		Du Pavé,	"	78.10	18.40	3.50
	Doué,	De Minières,	"	65.28	27.80	6.92
Haute-Loire,	Basin of Langeac,		M. Baudin,	74.00	26.00	7.10
Feroe Islands,	Suderoë I.	Brown coal,	Durocher,	24.50	37.50	38.00
Hesse Cassel, Coals.	Meissmer,	Anthracite,	M. Kuhnert,	70.19	14.34	15.47
	"	Pechkohle,	"	56.60	40.97	2.43
	Hirschberg,	"	"	60.83	38.36	0.81
	Habichtwald,	"	"	57.26	35.41	7.33
	Hirschberg,	Dry coal,	"	66.11	31.13	2.76
Lignite.	Habichtwald,	Lignite, passing to coal,	"	54.18	42.49	3.33
	"	Inferior lignite,	"	52.98	42.10	4.92
	"	Middle "	"	54.96	41.84	3.20
	Rigenkuhl,	Woody lignite,	"	51.70	47.01	1.29
	Stillberg,	Lignite,	"	50.78	42.27	6.95
		Peat or turf,	D. Mushet,	25.20	72.60	2.20
			Marcher,	65.00	22.00	13.00
			"	37.00	48.00	15.00
Southern Russia,	Cossack, Don,	Country of the Don best anthracite,	Voskressensky,	94.23		
	Tiflis,	Inferior,		63.64		
ITALY. Principality of Monaco,	Menton,	Earthy,	M. Diday,	49.20	29.90	20.90
SPAIN. Coals of Asturias.	Cueva,	One yard coal,	I. T. Cooper,	66.00	31.80	2.20
	Emanuela,	Three yard coal,	"	67.90	30.90	2.10
	Viena Alta,	Four yard coal,	"	63.60	33.90	2.50
		Mine of Clausel,	M. Berthier,	35.00	53.00	12.00
		Del Regueron,	"	43.00	44.00	13.00
		Mean of 5 other mines,	"	53.00	40.00	7.00
	Tudela,		M. Paillette,	65.80	32.27	1.93
	Mieres,		"	57.60	39.40	3.00
	Lama,		"	56.69	41.51	1.80
	Oloniego,		"	60.40	36.55	3.05
	Arnao,		"	45.69	45.11	9.20
	Ferrones,		"	46.98	46.91	6.11

Bituminous Coals in Belgium.

Countries, Provinces, and varieties of Coal.	Locality.	Designation of Coal beds.	By whom analysed.	Specific gravity.	Analysis. Carbon.	Oxygen and hydrogen.	Ashes.
Province of Hainault. Near Mons.	Dour,		Berthier,		71.50	23.30	5.20
	"		"	1.307	88.00		2.50
	"		"		85.00	12.70	2.30
			M. Canchy,	1.276	84.67	13.23	2.10
			"	1.292	83.87	12.47	3.68
	Basin of Mons,	Plate seam,	M. Chevalier,	1.273			1.98
	"		"	1.263			1.27
	"		Karsten,	1.307	85.50	12.00	2.50
	Canton of Dour,		Berthier,	1.270	71.50	23.30	5.20
	Near Mons,	Bouleau,	"	1.270	65.30	33.00	1.70
		Grand Gaillet,	"		58.50	38.50	3.00
		Gade vein,	"		51.00	44.00	5.00
Province of Liege.	Liege,	St. Margarite,	C. Davreux,		78.30	17.80	3.90
			"		76.00	19.60	4.40
			"		69.90	23.40	6.70
	"	Olisson,	"		72.60	24.20	3.20
	"	Cerisier,	"		68.50	21.20	10.30
Dry Coals.	Harion,	L'Harbe S. Michael,	M. Delvaux,	1.365	81.90	9.00	9.10
	Chokier,	Petite Hareng,	"	1·286	71.68	16.36	11.96
	Bonnier,	Moset seam,	"	1.318	91.38	8.00	6.12
GERMANY. *Bituminous coals.*							
Upper and Lower Silesia.	Waldenberg,	Glanz coal,	Richter,		57.20	36.40	6.40
	Sabrze,	"	"		63.20	32.93	3.90
	Bielschowitz,	"	"		58.17	37.89	8.93
	Leopoldinengrube,	"	Gay Lusac,		61.50	35.62	2.88
	Frederich zu Zawada,		Karsten,	1.263	57.90	42.00	2.10
	Gustaw Grube,		"	1.270	68.00	30.10	1.90
Saxon States.	Sälzer,	Newark,	"	1.288	81.60	17.70	0.70
"	"	"	Gay Lusach,		80.10	18.90	1.00
Prussian Saxony.	Circle of the Saale,	Wettin or Wittenberg,	Karsten,	1.466	56.70	18.90	24.40
Germany.	Brown coal,	Shraplau,			20.25	62.25	17.50
"	Eschweiler,	Flotz Gyr,	Gay Lusaok,		82.40	16.42	1.18
"		"	Karsten,	1.300	80.23	18.60	1.17
Saxony.	Pottschapel,	Gate Schicht,	"	1.454	41.00	31.30	27.70
"	Planitz,	Pitch coal,	"	1.860	63.40	35.50	1.10
Bohemia.	Elbogen,	Brown coal,	M. Balling,		37.18	56.16	6.66
"	Schlakenwerth,	Carbonized peat,	M. Debette,		67.00	30.00	3.00
Wurtemberg.	Kœnigsbrunn,	Raw peat,	M. Berthier,		24.40	70.60	5.00

ASIA.

Country.	Locality.	Designation of Coal beds.	By whom analysed.	Specific gravity.	Analysis. Carbon.	Volatile matter.	Ashes.
HINDOSTAN.							
Pres. Bengal,	Nerbudda,	Fatephur,			22.00	14.00	64.00
	Chirra Poonje,	Slaty,		1.447	41.00	36.00	23.00
Assam,	Cossyah or Kosya hills,	Few ashes,		1.275	60.70	38.50	.80
Pres. Bengal,	Prov. Delhi,	Hurdwar,		1.368	50.00	35.40	14.60
Birmese coast,	Aracan,			1.308	33.00	66.40	0.60
Turkey in Asia,	Anatolia,	Heraclea,	Prof. Hitchcock,		62.40	31.80	5.80
Syria,	Mt. Lebanon,	Asphaltum,	"		24.40	68.00	7.60
"	Mt. Hermon,	Anti-Libanus,	"		14.00	72.60	13.40

ANALYSIS

OF

OTHER COMBUSTIBLE MINERALS REFERRED TO IN THIS WORK.

	Authority.	Carbon.	Hydrogen.	Oxygen.	Nitrogen.
Naphtha, bitume napthe,	Thomson,	82.2	14.8		
	Saussure,	87.60	12.78		
Petroleum, bitume petrole, Seneca oil of New York,	similar.				
Earthy bitumen, earthy mineral pitch,	similar.				
Elastic bitumen, bitumen flexible, of England,	Henry,	52.250	7.496	40.100	0.154
Of France,	"	58.260	4.890	36.746	0.104
Compact bitumen, asphalt, Matanzas,		71.84		14.66	
" Peru, Coxitambo,	Bousingalt,	75.00	9.50	15.50	
Amber, Succin, mineral resin,	Drappier,	80.59	7.31	6.73	
"	Ure,	70.68	11.62	7.77	
Halchettine, mountain tallow,	Johnston,	76.437	12.479		
Shererite, in lignite,	Macaire,	73.00	24.00		
Ozokerite, used as fuel in Moldavia,	Glocker,	85.204	13.787		
Mellite, Honeystone, Thuringia,	Klaproth,				
Retinasphalt, bitumen fragrans,	Hatchett,				
Fossil copal, Highgate resin,					

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THE END.